U.S. Army Corps of Engineers, Kansas City District

Interim Feasibility Report

EXHIBITS

Kansas Citys, Missouri and Kansas
Flood Damage Reduction Study
Interim Feasibility Report

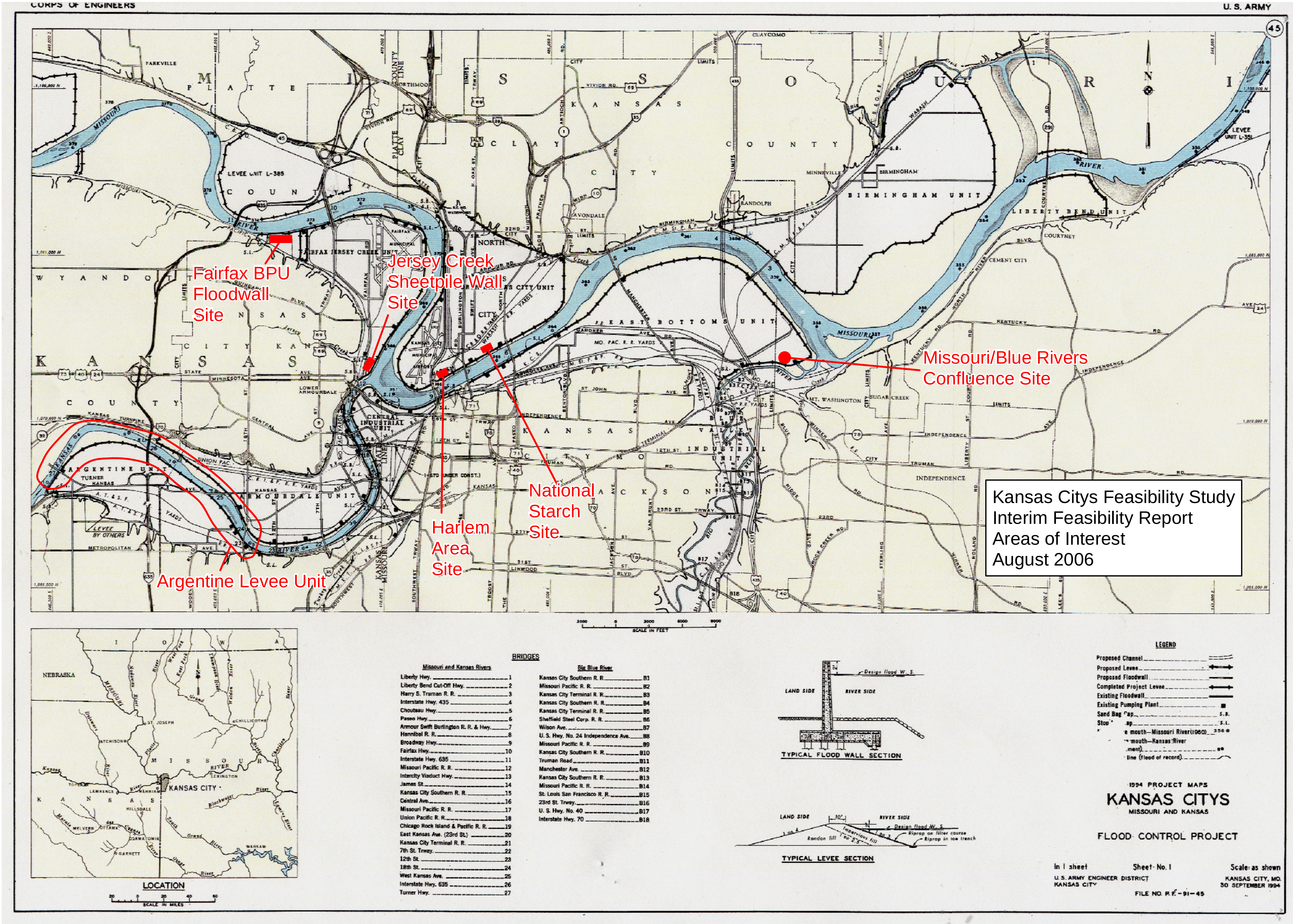

CORPS OF ENGINEERS
U. S. ARMY
Fairfax BPU Floodwall Site
Jersey Creek Sheetpile Wall Site
Missouri/Blue Rivers Confluence Site
National Starch Site
Harlem Area Site
Argentine Levee Unit
Kansas Citys Feasibility Study
Interim Feasibility Report
Areas of Interest
August 2006
BRIDGES
LEGEND
TYPICAL FLOOD WALL SECTION
TYPICAL LEVEE SECTION
LOCATION
1994 PROJECT MAPS
KANSAS CITYS
MISSOURI AND KANSAS
FLOOD CONTROL PROJECT

Exhibit #1

EXHIBIT #1a: Argentine Levee Unit – Overview Map

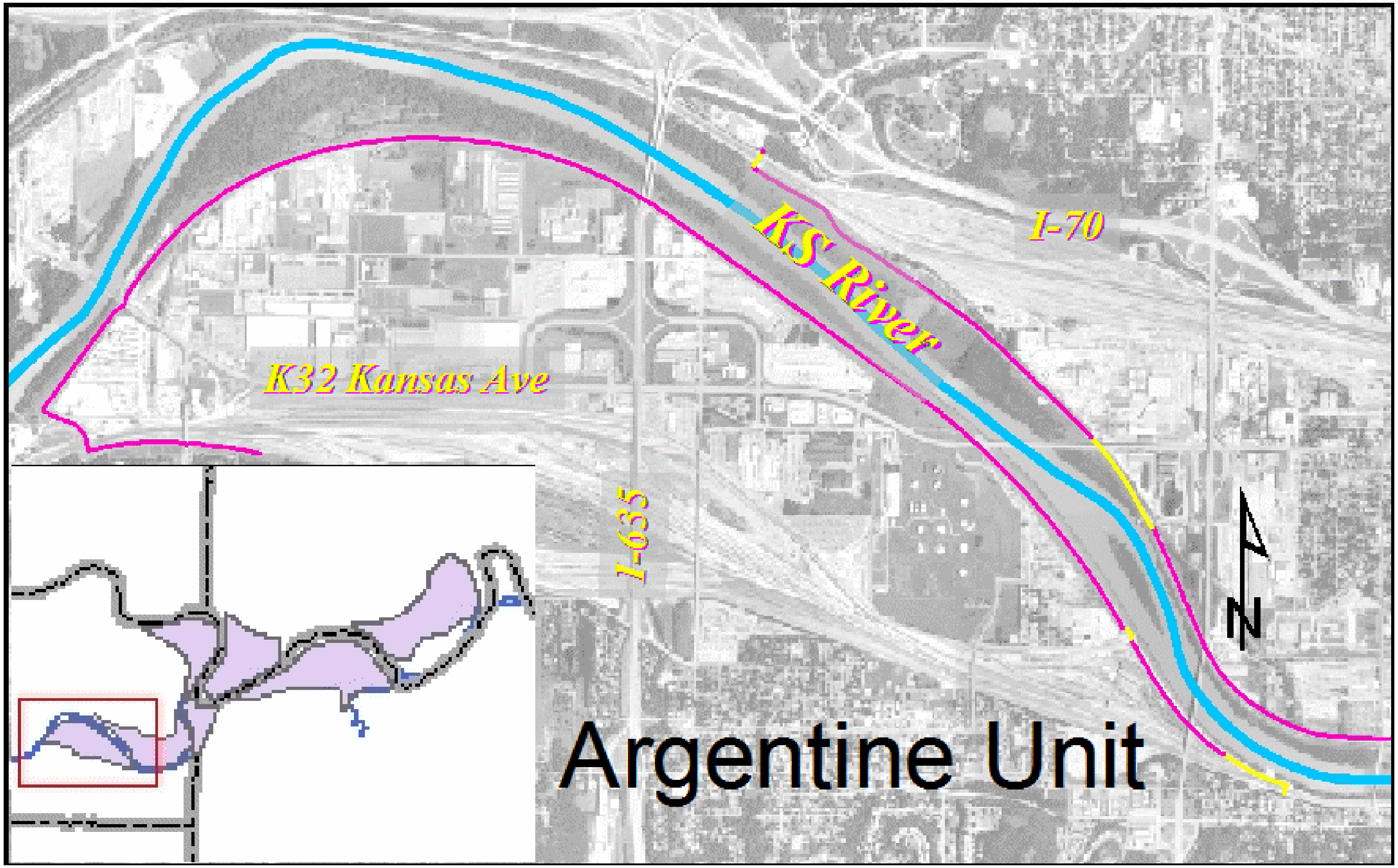
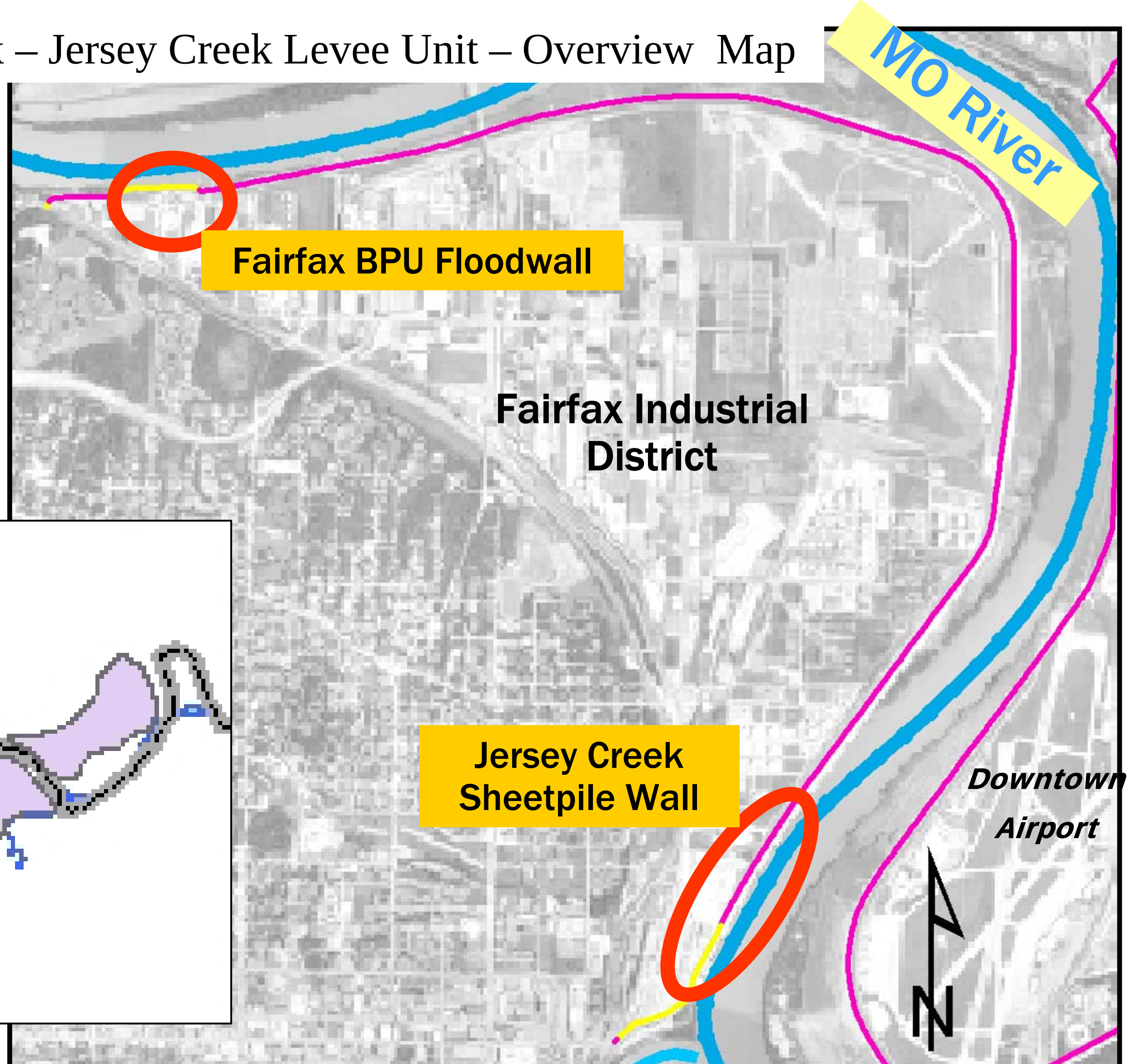


EXHIBIT #1a

EXHIBIT #1b: Fairfax – Jersey Creek Levee Unit – Overview Map

Fairfax – Jersey Creek Unit

Areas of Interest



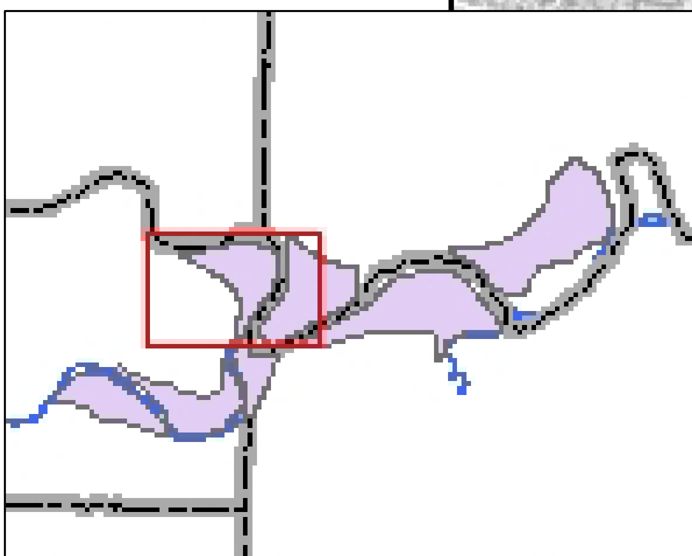
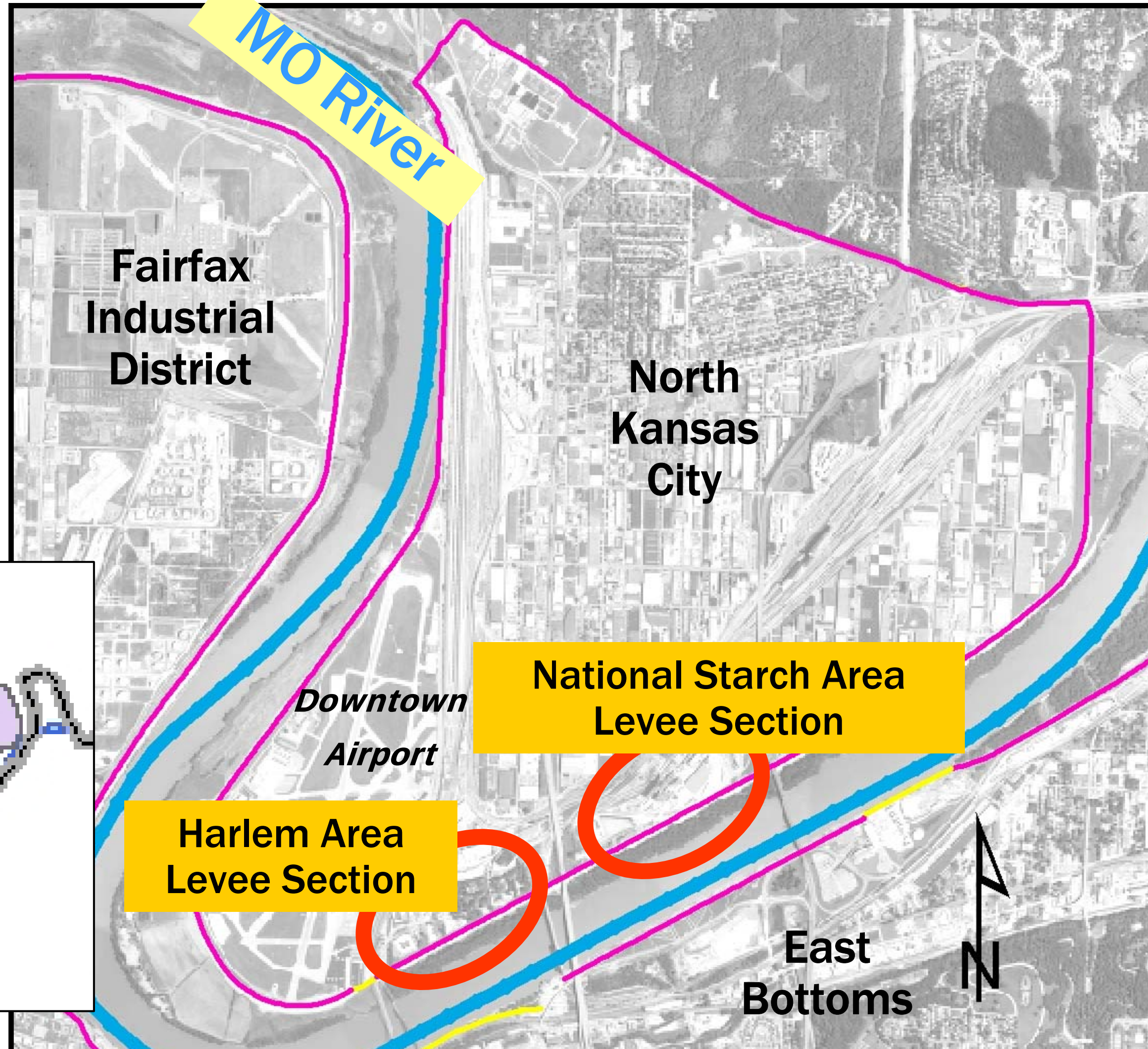


EXHIBIT #1b

EXHIBIT #1c: North Kansas City Levee Unit – Overview Map

North Kansas City Unit

Areas of Interest



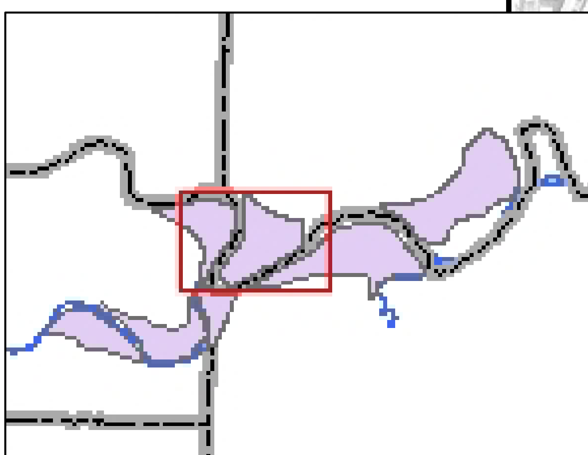


EXHIBIT #1c

EXHIBIT #1d: East Bottoms Levee Unit – Overview Map

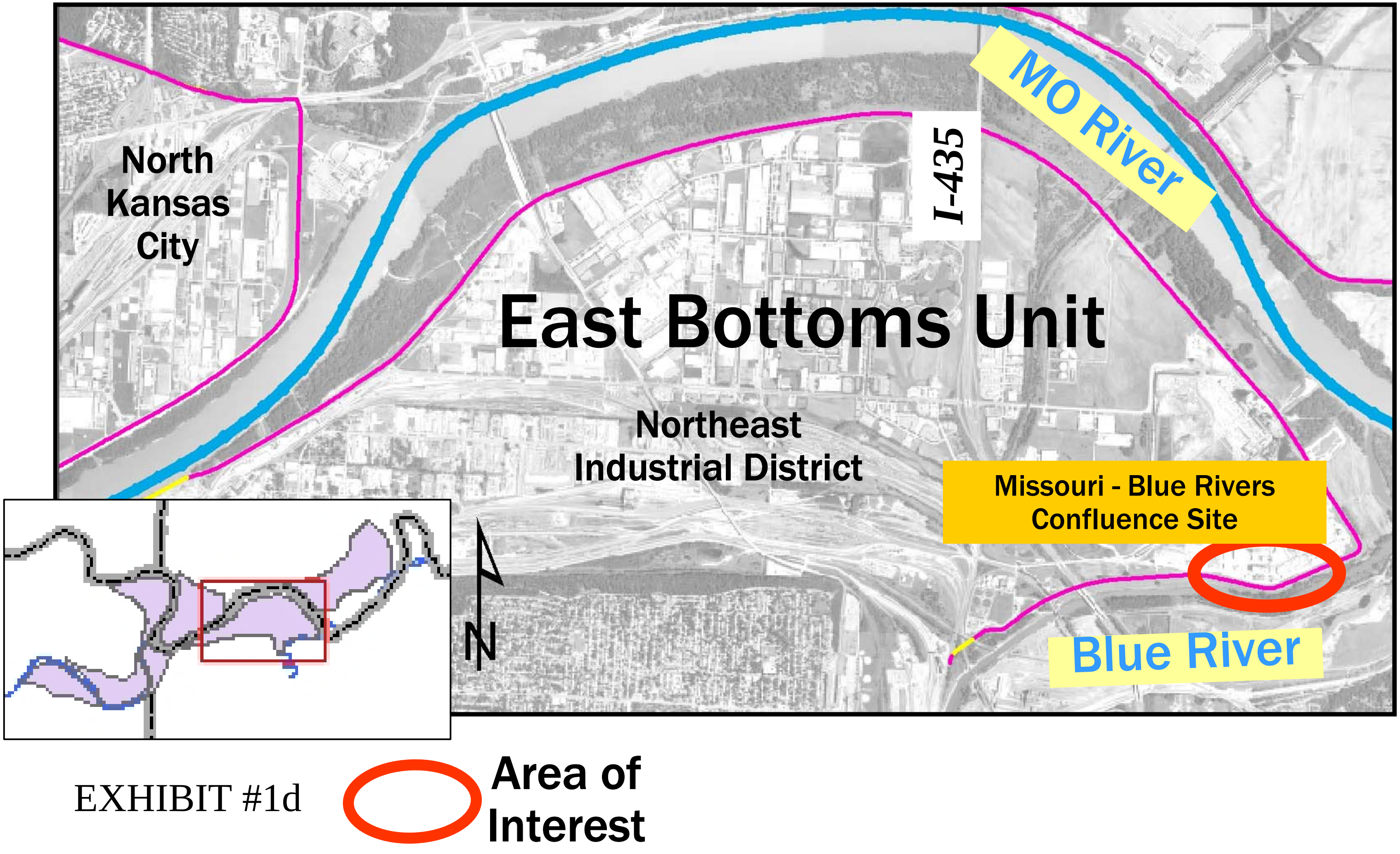


EXHIBIT #1d

EXHIBIT #2: Photograph of 1951 Kansas River Flood at Kansas City

- **Kansas River flood event**
- **Kansas River Basin lakes not operational**
- **All 3 Kansas River units overtopped in Kansas City**

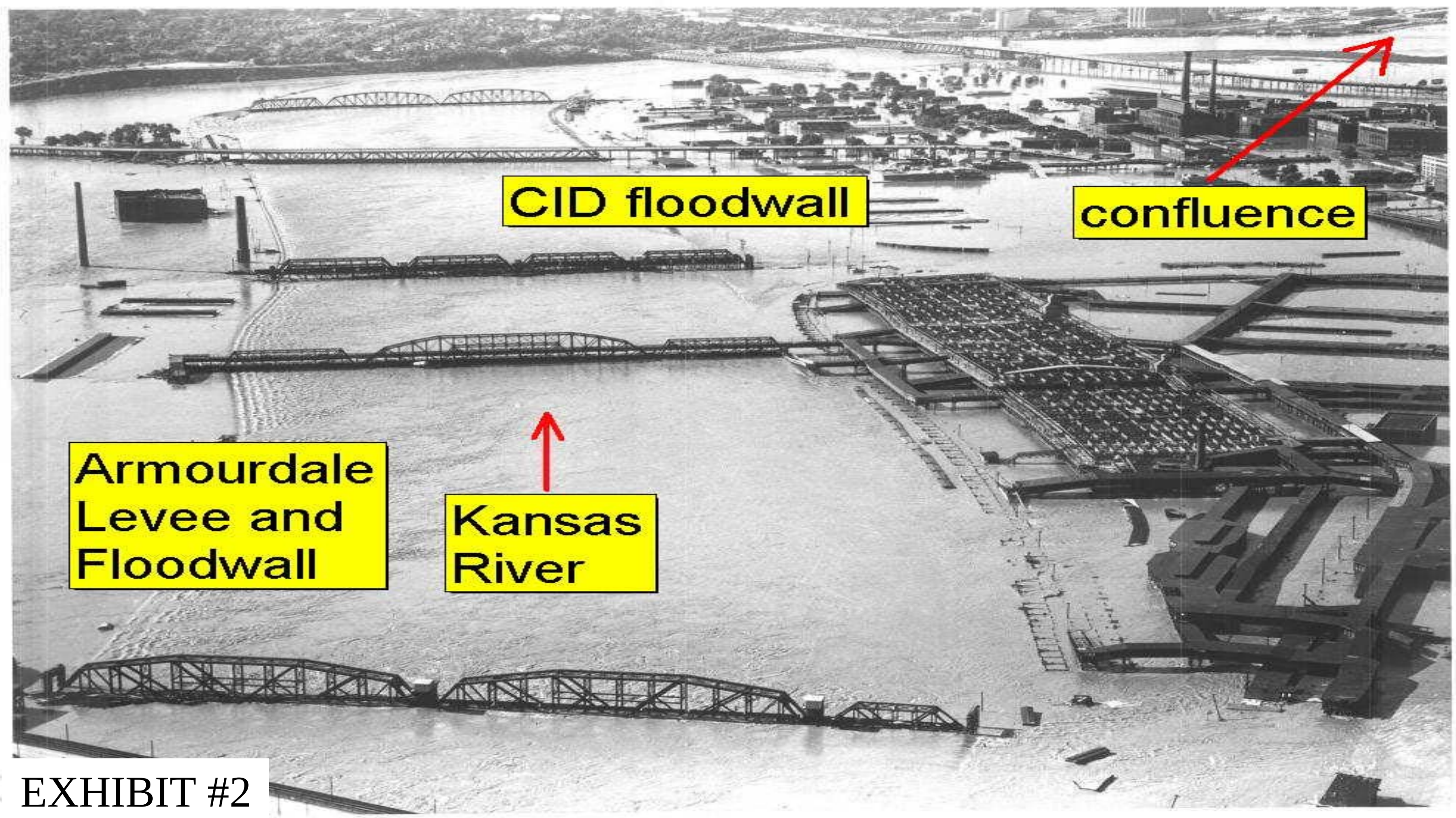


EXHIBIT #3: 1993 Flood Event Hydrograph
Kansas City Gage – Missouri River

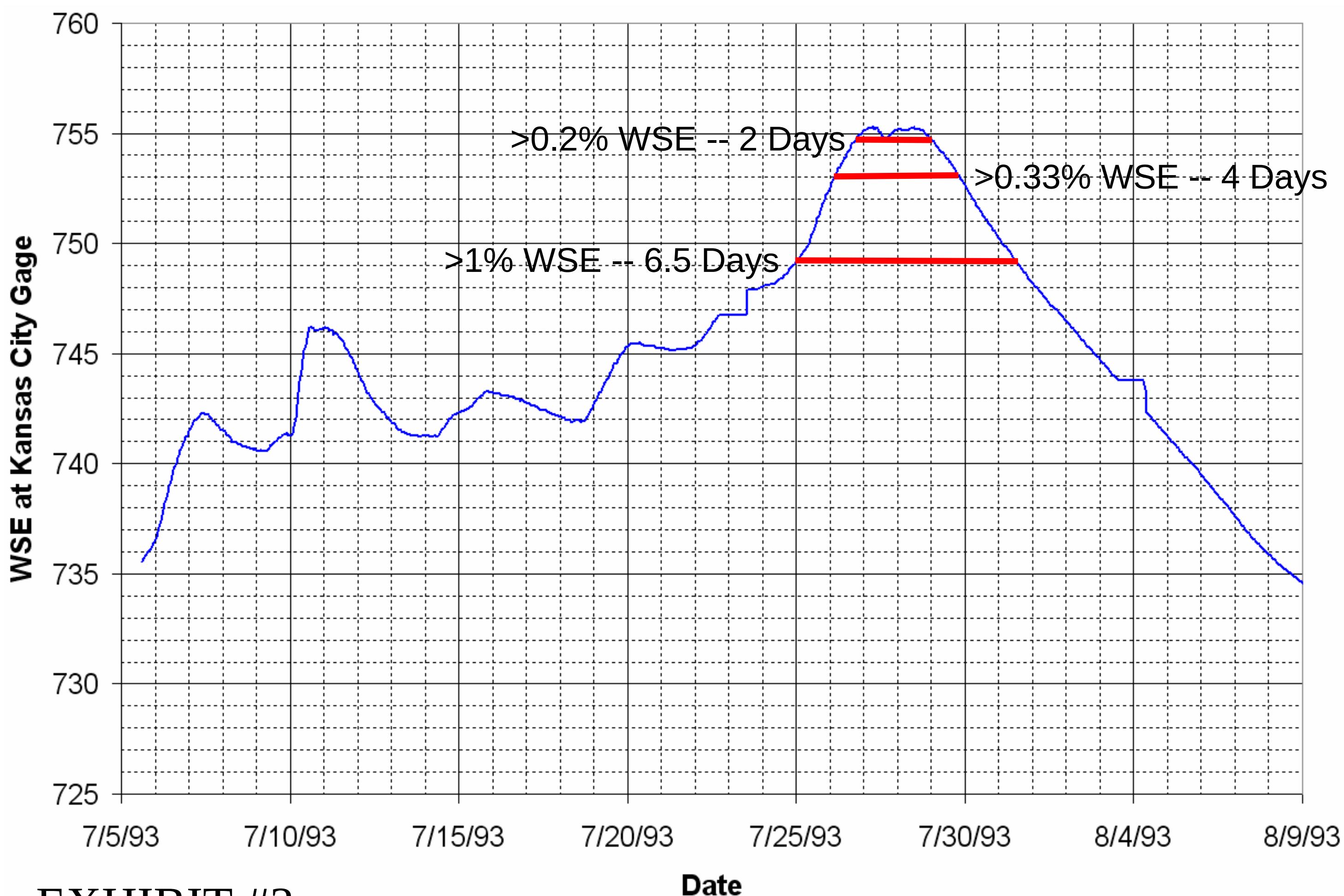


EXHIBIT #3

KANSAS CITYS
EXHIBIT #4: LEVEE UNITS EXISTING CONDITION OVERTOPPING PERFORMANCE

			EXISTING CONDITION UNIT PERFORMANCE AGAINST OVERTOPPING					EXISTING CONDITION POTENTIAL FAILURE SITES/MODES				
			1% EVENT		0.2% EVENT							
Unit	Existing Top of Levee Elevation* (ft msl)	Overtopping Expected Annual Exceedance Probability**	Nominal Water Surface Profile elevation at index point (ft.m.s.l.)	Margin (TOL elev minus 1% event elev)	Nominal Water Surface Profile elevation at index point (ft.m.s.l.)	Margin (TOL elev minus 0.2% event elev)	Differences between the design and existing levels of performance and the underlying causes, including degradation and related problems	Potential Structural and Geotechnical Failure Sites/Modes	Probability of Geotech/Struc Failure at TOL (overtopping point)	PFP (elev, ft msl)	PNP (elev, ft msl)	Consequences of potential Structural and Geotechnical Failures
ARGENTINE	776.0	0.002	769.61	6.4	778.24	-2.2	Changed channel geometry, slope, roughness	Arg Levee Embankment	0.317	776.0 (TOL)	775.2	Unit will flood.
							Different calibration event ('93 vs '51)	Arg Floodwall	0.006	776.0 (TOL)	776.0 (TOL)	Unit will flood.
							Different flood hydrograph due to reservoir control	Strong Ave Pump Station	0.919	775.2	767.6	Unit will flood.
								Argentine Pump Station	0.953	774.8	767.3	Unit will flood.
FAIRFAX-JERSEY CR	760.5	0.000***	751.53	9.0	757.61	2.9	JC Sheetpile Wall: bed degradation, scouring during 1993 event; deterioration, end of design life	JC Sheetpile Wall	0.400	760.5 (TOL)	751.7	Unit will flood.
							BPU floodwall: insufficient pile strength (bending capacity)	BPU Floodwall	0.961	760.1	758.6	Unit will flood.
								Lower tieback Floodfight	0.329	760.5 (TOL)	759.5	Unit will flood.
								JC Outlet Floodfight	0.086	760.5 (TOL)	760.5 (TOL)	Unit will flood.
NORTH KANSAS CITY UNIT	755.5	0.001	748.81	6.7	754.45	1.0	Geotechnical underseepage problems identified during 1993 flood event	Harlem Underseepage Site	0.423	755.5 (TOL)	750.7	Unit will flood.
								National Starch Underseepage Site	0.351	755.5 (TOL)	752.4	Unit will flood.
EAST BOTTOMS UNIT	746.3	0.000	738.26	8.0	742.63	3.7	Geotechnical underseepage problems identified during 1993 flood event	Miissouri/Blue Confluence Underseepage Site	0.197	746.3 (TOL)	744.3	Unit will flood.
								Floodwall Sta 64+48 to 74+56	0.044	746.3 (TOL)	746.3 (TOL)	Unit will flood.

NOTES:
* TOL elevation represents the low spot on the levee translated to the index point of the Unit.
** Based on Monte Carlo analyses of hydrologic and hydraulic uncertainties.
***Overtopping Reliability shown for Fairfax-Jersey Creek Unit assumes a successful flood fight at lower tieback and JC outlet

EXHIBIT #4

KANSAS CITYS

EXHIBIT #5: LEVEE UNITS EXISTING CONDITION OVERALL PERFORMANCE

UNIT	Existing Top Of Levee (TOL) Elev (ft msl; adjusted to index point)*	GEOTECHNICAL/STRUCTURAL RISK					OVERALL EXPECTED ANNUAL EXCEEDANCE PROBABILITY	OVERALL UNIT RELIABILITY AGAINST THE 1% EVENT (Conditional Non-Exceedance Probability)		CONSEQUENCES OF FAILURE (costs, impacts)	LIKELY ACTIONS IN THE EVENT OF FAILURE
		Existing Condition Combined Probability of Failure at TOL***	PFP (85% prob of failure) (Elev, ft msl)	PFP -- feet below TOL	PNP (15% prob of failure) (Elev, ft msl)	PNP -- feet below TOL		Existing Condition	Future Without-Project Condition		
ARGENTINE	776.0	0.998	772.75	3.3	766.74	9.3	0.013	0.49	0.49	Potential loss of 1 or more pump plants and damage to levee @ several $million. Potential loss of life; health and safety hazards; environmental issues; $1.7 billion primary physical flood damages in Arg (0.2% event); $272 million other cost of flooding in Arg(0.2% event); closure of major businesses and industries including some of national significance; temporary and potentially permanent job losses; shutdown of nation's 2nd busiest rail yard, rail routes, intermodal facilities, and interstate; shutdown of major public and critical facilities.	Major flood fight; evacuation of 3,500 residents and 10,700 employees. Sponsors would request assistance from USACE under PL 84-99. Assuming sponsors have met all maintenance responsibilities, a permanent repair would be cost shared 75% Federal and 25% non-Federal. A temporary fix would be 100% Federal.
FAIRFAX-JERSEY CR	760.5	0.988	759.82	0.7	751.71	8.8	0.007	0.82**	0.82**	Potential 60-80 foot deep scour; loss of pump plants and relief wells, damage to levee and floodwall could total a few million to several million dollars. Potential loss of life; health and safety hazards; environmental issues; $2.3 billion primary physica flood damage (0.2% event); $320 million other cost of flooding (0.2% event); closure of major businesses and industries including some of national significance; temporary and potentially permanent job losses; shutdown of major rail yard, rail routes, and interstate shutdown; shutdown of major public and critical facilities.	Major flood fight; evacuation of 11,200 employees. Sponsors would request assistance from USACE under PL 84-99. Assuming sponsors have met all maintenance responsibilities, a permanent repair would be cost shared 75% Federal and 25% non-Federal. A temporary fix would be 100% Federal.
NORTH KANSAS CITY UNIT	755.5	0.633	755.50	0.0	750.05	5.5	0.005	0.85	0.85	Potential loss of life; health and safety hazards; environmental issues; $1.9 billion primary physical flood damage (0.2% event); $325 million other cost of flooding (0.2% event); closure of major businesses and industries including some of nationa significance; temporary and potentially permanent job losses; shutdown of major rai yard, rail routes, and interstate shutdown; shutdown of major public and critical facilities.	Major flood fight; evacuation of 4,900 residents and 26,700 employees. Sponsors would request assistance from USACE under PL 84-99. Assuming sponsors have met all maintenance responsibilities, a permanent repair would be cost shared 75% Federal and 25% non-Federal. A temporary fix would be 100% Federal.
EAST BOTTOMS UNIT	746.3	0.240	746.30	0.0	744.20	2.1	0.002	0.96	0.96	Potential loss of life; health and safety hazards; environmental issues; $1.87 billion primary physical flood damage (0.2% event); $230 million other cost of flooding (0.2% event); closure of major businesses and industries including some of nationa significance; temporary and potentially permanent job losses; shutdown of major rai yard, rail routes, and interstate shutdown; shutdown of major public and critical facilities.	Major flood fight; evacuation of 3,300 residents and 20,150 employees. Sponsors would request assistance from USACE under PL 84-99. Assuming sponsors have met all maintenance responsibilities, a permanent repair would be cost shared 75% Federal and 25% non-Federal. A temporary fix would be 100% Federal.

NOTES:

* TOL elevation represents the low spot on the levee translated to the index point of the Unit.

**Reliability shown for Fairfax-Jersey Creek Unit assumes a successful flood fight at lower tieback and JC outlet

*** Combined probability of failure curve was computed using formula in ETL 1110-2-556; formula: Pr(f)=1-(1-pA)(1-pB)(1-pC)(1-pD)

EXHIBIT #6: Existing Condition Expected Annual Damages

Levee Unit	Existing Condition Expected Annual Physical Damages (Oct 2004 Prices, $000)						Existing Condition Expected Annual Other Costs of Flooding				Existing Condition Total Expected Annual Damage
Levee Unit	**Comm**	**Ind**	**Pub**	**Res**	**Crop**	**Total Physical Damage**	**Clean-up**	**Emerg & Reloc/ Reoccup**	**Traffic Disrup**	**Total Other Costs of Flooding**	
Argentine	$8,600.8	$8,284.5	$1,328.5	$372.0	$0.00	$18,585.0	$465.9	$2,480.6	$9.5	$2,956.0	$21,541.0
Armourdale*	TBD	TBD	TBD	TBD	TBD	TBD					
CID *	TBD	TBD	TBD	TBD	TBD	TBD					
Birmingham	$315.1	$49.9	$28.7	$65.6	$0.7	$460.1	$10.7	$49.0	$2.7	$62.4	$522.5
East Bottoms	$1,421.6	$4,137.4	$571.9	$14.5	$0.00	$6,145.4	$133.0	$628.5	$16.8	$778.2	$6,923.6
North Kansas City	$2,882.9	$4,981.8	$816.9	$926.7	$0.00	$9,608.3	$292.6	$1,337.6	$31.3	$1,661.5	$11,269.8
Fairfax	$559.8	$13,013.1	$401.4	$0.0	$0.00	$13,974.3	$297.1	$1,599.3	$4.0	$1,900.4	$15,874.7
Total	$13,799.3	$30,466.9	$3,147.5	$1,378.8	$0.7	$48,773.2	$1,199.3	$6,095.0	$64.3	$7,358.5	$56,131.7

*To be determined for the final report.
Any discrepancies due to rounding.

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit PUMP PLANTS				
Name / Station (ft) or Location	Design Flood Elevation (ft)	Contributing Flows	River Discharge Conduit(s)	Comments
Turner Station (Kaw Valley Pump No. 4) / 60+40 (42+41[1])	776.8	(1) Storm Sewer System Flow: The delivery system is a closed sewer paralleling Kansas State Hwy. 132 to the north. (2) Seepage Flow: Service area is between Sta. 68+00 to Sta. 156+00, totaling 13.4 cfs, currently ponds in undrained sites.	Twin 5'x8' RCB	A. The extra room for future pumping capacity was accounted for in the original design. B. The original sewer system was designed to serve 434 acres and assumed that area to be fully developed. B. Stage 20.0 ft is when the pumping is initiated, which is the point when the HGL is 3 ft below then lowest MH. C. It was determined that the whole drainage area would not contribute to the peak runoff. D. Time of concentration was based upon the 434 acre tract serviced by the sewer system, not the total area. E. The Bulk Mail center has been built in this area and services a portion of the original 625 acres. 625 acres has been reduced to approximately 594 acres. This might have alleviated any burden that the extra impervious area would have caused. The percent impervious was estimated from 1996 aerial photography. F. Two pumps were added (outside) in the 1980s.
Bulk Mail / 131+50 PRIVATE Noncompensable	774.7	Storm Runoff	48" CIP	A. This pump plant services the Post Office property. B. The plant was not analyzed in the overall hydrology within the "Supplement on Interior Drainage". C. The pump plant is owned and operated by the Post Office. D. The percent impervious was estimated by visual inspection of 1996 aerial photography. E. The drainage district sponsor explained that this pump is not critical to the integrity of the levee. If the Bulk Mail pump was to go off-line the water would pond on the Bulk Mail Center property and some runoff would flow to the Turner Pump Station. The Turner Station would be able to handle the small amount of additional runoff contributed by the Bulk Mail Center because this area was originally designated to contribute to the Turner Station.
ConAgra / 145+00 PRIVATE Noncompensable	774.5	Storm Runoff	36" RCP	A. This pump plant services what used to be the Swift Packing Company property - it is now ConAgra. B. The plant was not analyzed in the overall hydrology within the "Supplement on Interior Drainage". C. The pump plant is owned and operated by ConAgra. D. The percent impervious was estimated by visual inspection of 1996 aerial photography. E. The drainage district sponsor explained that this pump is not critical to the integrity of the levee. If pump was to go off-line the water would pond on the ConAgra property. Some runoff would flow to the Turner Pump Station. The Turner Station would be able to handle the small amount of addition runoff contributed by the ConAgra land because this area was originally designated to contribute to the Turner Station.
Argentine / 253+14 (242+97[1])	771.6	Storm Sewer System Flow: This collects local runoff, which is collected in two separate ditches. Main ditch collects water from the uplands. The North ditch collects water from the bottoms.	9.5'x9' RCB	A. The sewer and ditch system that services this area has sufficient capacity up to the confluence of the North Santa Fe Ditch and The Main Santa Fe Ditch. At this confluence point the maximum runoff of 2029 cfs at stage 14.0 is too great for a conduit that only has a maximum capacity of 790 cfs. B. The conduit mentioned in comment "A" is a continuous composite conduit. The inlet is an 11' x 8' RCB that leads into a 9.5'x9 RCB which ties into the pump station. C. Ponding that occurs under the pumping conditions is less then the ponding that occurs unavoidably under gravity flow conditions at stage 14.0. Therefore, extra pumping capacity will not solve the most severe ponding condition. D. Gravity flow capacity equals pumping capacity at stage 26 (752.8), yet the gates must be closed at stage 23.6 (elev. 750.8) to prevent backflow from the Kansas River inundating the catch basins near 23rd & Argentine. E. The service area has been reduced by 134 acres due to the construction of the Ruby Street Sewe F. One new pump was added to this station in recent years, located just outside the pump house.

Note: Unless shown otherwise, stages given refer to the Kansas City gage on the Hannibal Bridge at Missouri River mile 366.1 using the original datum of 715.79. This original datum was in use from February, 1948 to October, 1989, when the current datum of 706.4 went into effect. Elevations in the table correspond to the river at the pump plant location.

Superscript 1 refers to 1950 levee stationing.

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit PUMP PLANTS				
Name / Station (ft) or Location	Design Flood Elevation (ft)	Contributing Flows	River Discharge Conduit(s)	Comments
Santa Fe Yards / 253+36 (248+19[1]) PRIVATE Compensable	771.4	Storm Sewer System Flow: Runoff from the southeast portion of the RR yards, a small amount of nearby residential runoff, and a small amount of over flow from the Strong Ave. Sewer.	4'x5' RCB	A. Ponding occurs at the inlet of the 36" pipe, point 16 (see 1950 "Supplement on Interior Drainage" plate 33) that passes underneath the tracks and drains a low area south of the tracks. The 36" pipe drains the bypass flow from the Strong Ave Sewer. B. Ponding occurs near the rail car repair shop at MH #22 and #23. (see 1950 "Supplemental on Interior Drainage" plate 33) C. At the turntable, ponding is 1.5 ft due to the lack of sewer capacity. This ponding could easily be prevented by installing a 12" flap gate on the 12" line in manhole 57 (see 1950 "Supplement on Interior Drainage" plate 33). D. During the site visit interview, the team was told there is a significant amount of ponding due to the lack of pumping capacity of this plant. The Santa Fe Railroad, pumps all storm drainage on their property to a holding tank. The water is held in the tank to separate the oil (diesel fuel) from the water. The water is then pumped into the Kansas City Kansas sanitary sewer system. Santa Fe railroad no longer gravity discharges to the river. The option to discharge to the river is still available, but is not done unless absolutely necessary.
Strong Ave. / 273+41 (263+21[1])	771.1	Storm Sewer System Flow: Flow from a residential area south and west of the railroad yards.	84" RCP	A. The analysis in the 1950 "Supplement on Interior Drainage" shows that gravity discharge out performs pump discharge when the river stage is below 23.0 ft. Therefore, it was suggested to start the pumping at stage 23.0 instead of stage 16.0. B. The original pump plant had only one 16" centrifugal sewage pump, which was insufficient to pump the QSystem Capacity. Yet due to the extreme insufficient capacity of the sewer system it was shown that increasing the pump capacity would not solve the ponding problem, because the most extreme ponding occurred under gravity flow conditions. This is probably why the Ruby Street Sewer system was constructe C. The City of KCK, in the 1990s, constructed a pump station at 26th and Strong Avenue. At some stage of a design rainfall event, storm water is diverted from the Strong Avenue sewer to the Ruby Avenue storm sewer. The Strong Ave. Sewer has been made to be predominately a sanitary sewer with the construction of the Ruby Street Sewer system (which now collects the majority of the storm runoff that originally was collected by the Strong Ave. Sewer) and added the connection to the 16th Street Sanitary Sewer. D. The service area has been reduced in size from 607 to 175 acres since its original design. E. An 18" Cascade pump was installed in 1995. It is believed to replace the function of the 16" Worthington pump. The 18" pump is cited to have a capacity of 8000 gpm @ 39.5' TDH. The 16" was cited to have only 6000 gpm at the same TDH; therefore the capacity has increased. (see the pump curve found in the 1950 "Supplement on Interior Drainage", plate 43)

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Superscript 1 refers to 1950 levee stationing.

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit STORM SEWERS AND OUTFALLS						
Description	Location		Structure Information			Comments
	Levee Station (ft)	Offset to Outlet (ft)	Conduit Size	Conduit Composition	Control Structure Type LW = landward RW = riverward	
Conduit just west of 55th Street: This drains a relatively small amount of flow that accumulates near the toe of the levee at the inlet.	13+75	50	12"	CMP	Flap gate (RW)	A. The conduit drains a small area along the toe of the levee, as shown by the operational drawings of the latest O&M manual. B. This drainage structure was not analyzed in the overall hydrologic analysis within the "Supplement on Interior Drainage". C. The conditions of the area draining to this structure have not changed significantly since the conduit's design.
Turner Ditch Outlet: The flow is transported by Turner Ditch which parallels Thorne Road and services this area.	35+10 (16+50[1])	130	36"	RCP	Flap Gate (RW) Sluice Gate (LW)	A. The upstream ditch controls the flow to be discharged through the 36" RCP. B. The capacity of the drainage system described in the 1950 "Supplement on Interior Drainage" was based upon an area of 24 acres and a time of concentration of 64 minutes. Since then the area has been increased to 50 acres due to the expansion of the Lock Joint Company. This, in turn, increased the percent impervious. C. The original outlet (10' x 3' RCB with 4' x 3' bulk head) has been abandoned. It was replaced by a 36" RCP in 1958.
Turner Industrial Sewer (Turner Pump Station Outlet)	60+40 (42+41[1])	124	2 - 5'W X 8'H	RCB	Leaf Gate (RW) Sluice Gate (LW)	A. This is the outlet structure for Turner Pump Station. B. The time of concentration was based upon the area serviced by the sewer system (a 434 acre tract). C. The sewer system was designed based upon the assumption that only 434 acres would be developed. Therefore, if more development occurs within the total 625 acres area, then the sewer may not have capacity. D. The system was designed so that at no point in the system the HGL would be higher the 3 ft below the ground level. E. The entire 625 acres is now developed. The Bulk Mail Center and ConAgra pump plants have been built in this area and service a portion of the original 625 acres. The 625 acres contributing to the Turner pump plant has been reduced to approximately 574 acres. This alleviated any burden that the extra impervious area would have caused. This area is now developed with the construciton of Bulk Mail Center and the ConAgra. The maximum seepage flow rate of 13.4 cfs at stage 40.8 no longer applies because the pumps located on each of the developed areas now assume a portion of this flow. Maximum ponding of 125 acre-ft no longer applies because the ponding is now pumped to the river during high river stages.
Thompson-Hayward Chemical Company: The conduit services miscellaneous drainage from the industry.	97+70	55	8"	CIP	Gate Valve (RW)	A. This drainage structure was not analyzed in the overall hydrology within the "Supplement on Interior Drainage". B. This conduit is not believed to be a storm drainage structure. A pipe profile was found which shows that the flow type must be pressure; because the flow type and size it is believed to be a force water main. C. As the contributing flow is assumed to be industrial flow, the adequacy of the conduit is not affected by storm events. However, conditions have not significantly changed in the area.

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EXHIBIT #7

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit STORM SEWERS AND OUTFALLS						
Description	Location		Structure Information			Comments
	Levee Station (ft)	Offset to Outlet (ft)	Conduit Size	Conduit Composition	Control Structure Type LW = landward RW = riverward	
Thompson-Hayward Chemical Company: The conduit services miscellaneous drainage from the industry.	104+85	55	4"	CIP	Gate Valve (RW)	A. This pipe was not analyzed to drain any large drainage areas. B. It appears that this pipe drains a small pond located on the Thompson-Hayward Chemical Company property. The exact function of the pond is not known. C. As the contributing flow is assumed to be industrial flow, the adequacy of the conduit is not affected by storm events. However, conditions have not significantly changed in the area.
Bulk Mail Center	131+33	***	20"	SP	Flap Gate (RW)	A. This pipe is one of the two force main pipes that carry water pumped by the Bulk Mail Center Pump Plant to the gatewell structure. These pipes cross the levee because the gatewell structure is on the riverside of the levee. B. As alluded to in the table, this conduit is only dependent upon the Bulk Mail Center Pump Plant operation.
Bulk Mail Center	131+37	***	36"	SP	Flap Gate (RW)	A. This pipe is one of the two force main pipes that carry water pumped by the Bulk Mail Center Pump Plant to the gatewell structure. These pipes cross the levee because the gatewell structure is on the riverside of the levee. B. As alluded to in the table, this conduit is only dependent upon the Bulk Mail Center Pump Plant operation.
Bulk Mail Center	131+50	***	48"	CIP	Sluice Gate (RW)	A. This drainage structure was not analyzed in the overall hydrologic analysis researched by the team. B. The seepage flow is contributed from the area between approximately station 120+00 to station 140+00. C. This conduit is the gravity outlet structure for Bulk Mail Center Pump Station. D. The Bulk Mail Center was constructed in an area that was originally used to store seepage flow during high river stages. A portion of the flows described in the 1950 "Supplement on Interior Drainage", paragraph 13 is now pumped through this outfall by in-house pumps located on this property. Consequently, the pumps have relieved the load on the Turner Pump Station. E. The Bulk Mail Center has been built in an area which was originally used for storage of seepage flow. This storage area has now been filled in. The percent impervious was estimated from visual inspection of 1996 aerial photography.

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Argentine Levee Unit STORM SEWERS AND OUTFALLS						
Description	Location		Structure Information			Comments
	Levee Station (ft)	Offset to Outlet (ft)	Conduit Size	Conduit Composition	Control Structure Type LW = landward RW = riverward	
ConAgra outlet (possible seepage outlet)	145+00 (127+00[1])	45	36"	RCP	Flap Gate (RW) Sluice Gate (RW)	A. This drainage structure was not analyzed in the overall hydrologic analysis researched by the team. B. The seepage flow is contributed from the area between station 140+00 to station 165+65. C. This conduit is the gravity outlet structure for ConAgra Pump Station. D. The Swift Packing Company (now ConAgra) was constructed in an area that was originally used to store seepage flow during high river stages. A portion of the flows described in the 1950 "Supplement on Interior Drainage", paragraph 13 is now pumped through this outfall by in-house pumps located on this property. Consequently, the pumps have relieved the load on the Turner Pump Station. E. The Swift Packing Company (now ConAgra) has been built in an area which was originally used for storage of seepage flow. This storage area has now been filled in. The percent impervious was estimated from visual inspection of 1996 aerial photography.
Detention Pond outlet	190+00	***	60"	RCP	Flap Gate (RW) Sluice Gate (RW)	A. It appears to be the outlet structure of a detention pond adjacent to it. The detention pond was located during the site visits. The exact purpose of the detention pond is unknown. B. This drainage structure was not analyzed in the overall hydrologic analyses researched by the team. C. The 16" CIP at station 210+73 was described in the 1950 "Supplement on Interior Drainage" to discharge seepage that ponds in this area. It is believed that this 60" RCP now performs the seepage discharge function. Seepage is contributed from the area between station 165+65 (156+001) and station 212+50 (200+001) D. The condition at the Design Flood Stage is shown. The gate will be closed and the flow though the pipe will be zero. The pipe will discharge only when the river is low enough. The purpose of this pipe will simply be to speed up the removal of seepage water. The ponded seepage water will now have a direct outlet to the river as opposed to the slower process of being removed by infiltration and evaporation. E. The percent impervious was estimated by visual inspection of 1996 aerial photography and it does not appear that the conditions in the area of the pond have changed significantly over time.
Ramp Drainage	218+17		36"	RCP	Flap Gate (RW) Sluice Gate (LW)	A. This drainage structure was not analyzed in the overall hydrology. B. Drains the small area enclosed by an on-ramp to Kansas Ave. C. There are seepage flow ponds in the area adjacent to the levee (contributed from area between station 212+50 and station 253+14). Only the condition at the Design Flood stage is shown. The gate will be closed and the flow though the pipe will be zero. The pipe will discharge only when the river is low enough. The purpose of this pipe will simply be to speed up the removal of seepage water. The ponded seepage water will now have a direct outlet to the river as opposed to the slower process of being removed by infiltration and evaporation. D. The percent impervious was estimated by visual inspection of 1996 aerial photography and it does not appear that the conditions in the area of the ponds has changed significantly over time.

Note: Unless shown otherwise, stages given refer to the Kansas City gage on the Hannibal Bridge at Missouri River mile 366.1 using the original datum of 715.79. This original datum was in use from February, 1948 to October, 1989, when the current datum of 706.4 went into effect. Elevations in the table correspond to the river at the pipe location.

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit STORM SEWERS AND OUTFALLS						
Description	Location		Structure Information			Comments
	Levee Station (ft)	Offset to Outlet (ft)	Conduit Size	Conduit Composition	Control Structure Type LW = landward RW = riverward	
Sinclair Oil Company Outlet	247+32 (229+32[1])	109	24"	CIP	Flap Gate (RW) Sluice Gate (RW)	A. The conduit picks up Sinclair Oil Company area drainage (See 1962 "Design Memorandum No.2" refer to the Plate 33) B. This pipe drains the water that ponds on the Sinclair Oil Company property. The percent impervious was estimated by visual inspection of 1996 aerial photography and represent a similar condition to the design of the conduit.
Santa Fe Ditch System Outlet (Argentine Main station outlet)	253+14	40	9.0'W X 9.5'H	RCB	Sluice Gate (LW)	A. This is an outlet structure for the Argentine Pump Station (Kaw Valley East Pump). B. The conduit services the runoff from the railyards and the uplands. Runoff is collected by the Santa Fe Ditch system and ponds at the inlet of the 9.0' x 9.5' RCB. C. The drainage area is reduced by 134 acres due to the Ruby Street Sewer. D. Two new pumps were added to the Argentine Pump Station in recent years. They are located just outside the pump house. While specific information could not be obtained in a reasonable amount of time, a greater capacity is now available for pumping needs. This means that more flow could potentially be pumped through the outlet conduit.
Santa Fe Yard Sewer (Argentine Main Outlet)	258+36 (246+17[1])	93	4.0'H X 5.5'W	RCB	Leaf Gate (RW) Sluice Gate (LW)	A. This is the outlet structure for the Santa Fe Yards Pump Station. B. The conduit services the eastern tip of the railyards. C. The outfall conduit no longer discharges to the river. D. The pump plant pumps all drainage to a holding tank so that ponded water can be treated and discharged into the City's sanitary sewer system. E. The pump plant is not designed to drain the overflow from the Strong Avenue Sewer, but it is forced to during high intensity rainfalls when the Strong Avenue Sewer overflows. There are ponding problems which appear to be related to the pump capacities, but could potentially be related to outlet conduit.
Strong Avenue Sewer (Strong Ave Pump Station Outlet)	273+41 (263+21[1])	109	7.0'W X 7.0'H	RCB	Flap Gate (RW) Sluice Gate (LW)	A. This is the outlet structure for the Strong Avenue Pump Station. B. The Ruby Street Sewer System was built to intercept much of the storm runoff from the Strong Avenue Sewer and the Strong Avenue Sewer was made to intercept sanitary flow from the 16th Street Sewer and other sewers in the area, making it primarily a sanitary sewer. C. A low flow weir has been installed and the low flows are forced across the river and eventually to the treatment plant. D. The area was reduced from 517 acres to 175 acres (considered current design) when the Ruby Street Sewer System was built. The reduction of the drainage area decreased the severity of the surcharge problems of the Strong Avenue Sewer. However, the capacity of the pumps in the pump station is what controlled the flow received by the outlet conduits. The pump capacity was increased in recent years, putting more flow through the boxes.

Note: Unless shown otherwise, stages given refer to the Kansas City gage on the Hannibal Bridge at Missouri River mile 366.1 using the original datum of 715.79. This original datum was in use from February, 1948 to October, 1989, when the current datum of 706.4 went into effect. Elevations in the table correspond to the river at the pipe location.

EXHIBIT #7: Inventory Listing of Argentine Levee Pump Stations and Outlets/Drainage Structures

Argentine Levee Unit STORM SEWERS AND OUTFALLS						
Description	Location		Structure Information			Comments
	Levee Station (ft)	Offset to Outlet (ft)	Conduit Size	Conduit Composition	Control Structure Type LW = landward RW = riverward	
16th Street Sewer	280+48 (270+41[1])	83	36"	RCP	Flap Gate (RW) Sluice Gate (RW)	A. This outfall drains a residential area south of the tracks. The area served is above the design flood stage and is not subject to flood damage. B. There are two manholes in this system which are 0.8 ft below the design flood elevation. They need to be sandbagged at stage 31.2 feet. C. Ponding is a maximum at 14.0 ft. flood stage. D. The estimated percent impervious from visual inspection of 1996 aerial photography reflects the fact that the area has not changed significantly since original design of the outlet conduit.
Ruby Street Sewer System outlet	284+35 (274+25[1])	***	10'W X 10'H	RCB	Sluice Gate (Lw)	A. The Ruby Street Sewer was built by local interests in 1958 to handle the coincident 30-year event with a river stage of 14.0 feet. B. The area served is above the design flood stage and is not subject to flood damage. C. The system is designed to be a pressurized gravity flow pipe. D. Gates are seldom closed due to the steep HGL slope. A high river stage should not back flow out of the inlets. E. The purpose of this storm sewer system was to eliminate the surcharging of the Strong Avenue Sewer system and also to separate the storm flow from the sanitary. F. The percent impervious was estimated from visual inspection of 1996 aerial photography and reflects no significant change from the time of original conduit design.
Eastern End Conduit	288+10	***	6"	***	Gate valve (LW)	A. This drainage structure was not analyzed in the overall hydrologic analyses researched by the team. B. This structure appears to drain a small area near the toe of the floodwall, as shown by the operational drawing of the latest O&M manual. However, it could possibly just be a cable sleeve that passes through the levee. C. As the drainage district personnel are not aware of the purpose of this conduit, it is probably insignificant. However, personnel are not aware of any changes to the land in the vicinity of the conduit.

Note: Unless shown otherwise, stages given refer to the Kansas City gage on the Hannibal Bridge at Missouri River mile 366.1 using the original datum of 715.79. This original datum was in use from February, 1948 to October, 1989, when the current datum of 706.4 went into effect. Elevations in the table correspond to the river at the pipe location.

EXHIBIT #8: Future Without-Project Condition Equivalent Annual Damages

(Oct 2004 Prices, 5.375% Interest, 50 Year Period of Analysis, $000)

Levee Unit and Analysis Year	Physical Damages	Other Costs of Flooding	Total Annual Damages	Physical Damages as a % of Total	Other Costs of Flooding as a % of Total
ARGENTINE	$18,701.9	$2,974.4	$21,676.2	86%	14%
ARMOURDALE	TBD	TBD	TBD	TBD	TBD
CID (KS R. flooding)	TBD	TBD	TBD	TBD	TBD
CID (MO R. flooding)	TBD	TBD	TBD	TBD	TBD
BIRMINGHAM	$472.3	$64.1	$536.4	88%	12%
EAST BOTTOMS	$6,326.1	$804.3	$7,130.4	89%	11%
NORTH KANSAS CITY	$9,748.8	$1,685.8	$11,434.7	85%	15%
FAIRFAX-JERSEY CR.	$14,157.7	$1,926.3	$16,084.0	88%	12%
Study Area Totals	$49,406.7	$7,454.9	$56,861.7	87%	13%

Notes: -Data for Armourdale and CID will be determined for the final report.
-To avoid double counting, study area totals in the final report will not include CID damages from Missouri River flooding.
-Increases in Future Without Project damages over Existing Condition damages are based on currently ongoing and recently completed new economic investment in these units that was not included in the existing condition analyses and on increases in stage uncertainty between the base year and future year.

EXHIBIT #9: SCREENING CRITERIA FOR EARLY ALTERNTIVES ARRAY

LEVEE UNIT	Alternatives Considered	Engineering adequacy	Planning Objectives	Planning Constraints	Acceptability	Early Cost Indicators	Floodway Conveyance	Induced damages	Contamination Constraints	Constructability	Site Constraints	Screening Decisions (carry alternative forward for further economic analysis?)
ARGENTINE	Arg nominal 500+0 raise	+	+	+	+	+	+	-	+	+	+	Carry forward
	Arg nominal 500+3 raise (NED)	+	+	+	+	+	+	-	+	+	+	Carry forward
	Arg nominal 500+5 raise	+	+	+	+	+	+	-	+	+	-	Carry forward
	Arg No Raise, Pump Stations Only	/	/	+	+	+	+	+	+	+	+	Carry forward
	Flood fight	-	-	-	/	+	+	+	+	NA	-	Eliminate
	Tree Clearing along Foreshore	-	-	/	-	+	+	+	-	+	+	Eliminate
	Tree Clearing + Channel Mods	/	/	/	-	+	+	+	-	+	+	Eliminate
	No Federal Action	-	-	-	-	+	+	+	+	NA	NA	Eliminate
FAIRFAX-JERSEY CREEK (2 sites)	<u>BPU Floodwall Site</u>											
	Mod Wall (Add Piles & Buttress)	+	+	+	+	+	+	NA	NA	/	+	Carry forward
	Combo Wall (some new & some	+	+	+	+	+	+	NA	NA	/	+	Carry forward
	New Wall	+	+	+	+	+	+	NA	NA	-	-	Eliminate
	Jet Grouting Existing Wall	-	-	+	+	+	+	NA	NA	-	+	Eliminate
	Replace Floodwall w/ Earth Levee	+	+	+	-	+	+	NA	NA	-	-	Eliminate
	Temp Fill Behind Wall (flood fight)	-	-	-	/	+	+	NA	NA	NA	-	Eliminate
	No Federal Action	-	-	-	-	+	+	NA	NA	NA	NA	Eliminate
	<u>JC Sheetpile Wall & Wharf Area Site</u>											
	Flood fight	-	-	-	/	+	+	NA	NA	NA	-	Eliminate
	New Closed Cell Sheetpile Wall	+	+	+	+	+	+	NA	NA	/	+	Carry forward
	New Wall – Auger Cast Piles	+	+	+	+	-	+	NA	NA	/	-	Carry forward
	New Open Cell Sheetpile Wall	+	+	+	+	+	+	NA	NA	/	+	Carry forward
	No Federal Action	-	-	-	-	+	+	NA	NA	NA	NA	Eliminate
NORTH KANSAS CITY (2 sites)	<u>Harlem Site</u>											
	Flood fight	-	-	-	/	+	+	NA	NA	NA	-	Eliminate
	Landside Seepage Berm	+	+	-	-	-	+	NA	NA	-	-	Carry forward
	Buried Collector System	+	+	+	+	+	+	NA	NA	+	/	Carry forward
	Pressure Relief Well System	+	+	+	+	+	+	NA	NA	+	+	Carry forward
	No Federal Action	-	-	-	-	+	+	NA	NA	NA	NA	Eliminate
	<u>National Starch Site</u>											
	Relief Well System	+	+	+	+	+	+	NA	NA	+	+	Carry forward
	Flood fight	-	-	-	/	+	+	NA	NA	NA	-	Eliminate
	Landside Seepage Berm	+	+	-	-	-	+	NA	NA	-	-	Eliminate
	Buried Collector System	-	-	+	+	+	+	NA	NA	+	/	Eliminate
	No Federal Action	-	-	-	-	+	+	NA	NA	NA	NA	Eliminate
EAST BOTTOMS (MO & Blue confluence site)	Flood fight	-	-	-	/	+	+	NA	+	NA	-	Eliminate
	Sheetpile Wall	+	+	+	+	-	+	NA	+	-	+	Carry forward
	Slurry Cut-Off Wall	+	+	+	/	/	+	NA	+	-	+	Carry forward
	Pressure Relief Wells	+	+	+	+	+	+	NA	/	+	+	Carry forward
	No Federal Action	-	-	-	-	+	+	NA	+	NA	NA	Eliminate

<u>Screening Criteria</u>
- Engineering adequacy
- Contribution to planning objectives
- Consistency with planning constraints
- Environment/cultural & public acceptability
- Early Cost Indicators
- Benign to floodway conveyance
- Induced damages considerations
- Contamination Constraints or Impacts
- Constructability (quality construction at reasonable price
- Adapts readily to site constraints

<u>Codes</u>
- \+ = positive (desirable) implications based on the specific screening criteria
- \- = negative (undesirable) implications based on the specific screening criteria
- NA = screening criteria not applicable
- / = neutral implications based on the specific screening criteria

KANSAS CITYS
EXHIBIT #10: ALTERNATIVES--ECONOMICS SCREENING SUMMARY
Oct 04 prices, ($000, 50 year period of analysis, 5.375% Interest Rate)

Alternatives Considered, NED Plan for Each Unit, and Overall NED Plan	Future Without Project Annual Damages	Total Project First Cost*	Interest During Constr.	Project Economic Cost	Annualized Project Economic Cost	Expected Increase in Annual OMRR&R Cost****	Other Direct/Associated Costs (Annual)	Total Annual Cost*****	Annual Benefits *******	B/C Ratio	Net Benefits	Residual Damages	New Top of Levee/ Floodwall Elev (ft. m.s.l.)	WITHOUT PROJECT Reliability against the 1% event	WITH PROJECT Reliability against the 1% event	Other Beneficial Effects	Other Adverse Effects (accounted for in Other Direct/Associated Costs)*****
ARGENTINE UNIT	$ 21,676.2													0.49			
Arg 1, nominal 500+0 raise*		$ 30,372.0	$ 3,026.0	$ 33,398.0	$ 1,936.4	$ 12.2	Annual Induced Flood Damages and Private Pump Station Costs: $196.4	$ 2,145.0	$ 15,652.6	7.3	$ 13,507.6	$ 6,023.7	778.24		0.95	Preserves Riparian Acres in Urban Area	Temporary potential for induced flood damages downstream pending completion of raises for downstream units (Arm & CID)($185.2 annually). Some annual induced damages upstream ($2.1 annually). Cost for two private pump station facilities to remove, replace and relocate discharge piping over the new levee ($9.1 annually).
NED Plan: Arg 2, nominal 500+3 raise -- also see note ****** for discussion of the designation of the Argentine NED alternative*		*$ 52,568.0*	*$ 5,888.0*	*$ 58,456.0*	*$ 3,389.3*	*$ 12.2*	*Annual Induced Flood Damages and Private Pump Station Costs: $210.8*	*$ 3,612.3*	*$ 17,637.8*	*4.9*	*$ 14,025.5*	*$ 4,038.4*	*781.24*		*0.99*	*Preserves Riparian Acres in Urban Area*	*Temporary potential for induced flood damages downstream pending completion of raises for downstream units (Arm & CID)($199.1 annually). Some annual induced damages upstream ($2.6 annually). Cost for two private pump station facilities to remove, replace and relocate discharge piping over the new levee ($9.1 annually).*
Arg 3, nominal 500+5 raise*		$ 65,964.0	$ 7,279.0	$ 73,243.0	$ 4,246.7	$ 49.6	Annual Induced Flood Damages and Private Pump Station Costs: $215.0	$ 4,511.3	$ 18,635.5	4.1	$ 14,124.2	$ 3,040.8	783.24		0.99	Preserves Riparian Acres in Urban Area	Temporary potential for induced flood damages downstream pending completion of raises for downstream units (Arm & CID)($203.0 annually). Some annual induced damages upstream ($2.9 annually). Cost for two private pump station facilities to remove, replace and relocate discharge piping over the new levee ($9.1 annually).
Arg 4, No Raise, Pump Sta Remedies & Earthwork*		$ 15,598.0	$ 815.0	$ 16,413.0	$ 951.6	$ 12.2	-	$ 963.8	$ 13,443.0	13.9	$ 12,479.2	$ 8,233.2	no chg		0.90		
FAIRFAX-JERSEY CR UNIT (2 sites)	$ 16,084.0													0.82			
BPU Floodwall Site																	
Alt 1, Modified Wall (Add'l Row of Piles & Buttresses)		*$ 7,109.0*	*$ 550.8*	*$ 7,659.8*	*$ 444.1*	*$ 2.0*	-	*$ 446.1*	*$ 719.9*	*1.6*	*$ 273.8*	*$ 15,364.1*	*no chg*		*0.82*		
Alt 2, Combo Wall		$ 7,500.0	$ 583.0	$ 8,083.0	$ 468.7	$ 2.0	-	$ 470.7	$ 719.9	1.5	$ 249.2	$ 15,364.1	no chg		0.82		
JC Sheetpile Wall & Wharf Area Site*																	
Alt 1 Flood Fight**																	
Alt 2, New Closed Cell Sheetpile Wall		$ 10,866.0	$ 607.3	$ 11,473.3	$ 665.2	$ 2.0	-	$ 667.2	$ 10,411.4	15.6	$ 9,744.2	$ 5,672.6	no chg		0.98		
Alt 3, New Wall, Auger Cast Piles & Tiebacks		$ 9,629.0	$ 538.1	$ 10,167.1	$ 589.5	$ 2.0	-	$ 591.5	$ 10,411.4	17.6	$ 9,819.9	$ 5,672.6	no chg		0.98		
Alt 4, New Open Cell Sheetpile Wall		*$ 8,575.0*	*$ 479.2*	*$ 9,054.2*	*$ 525.0*	*$ 2.0*	-	*$ 527.0*	*$ 10,411.4*	*19.8*	*$ 9,884.4*	*$ 5,672.6*	*no chg*		*0.98*		
NED PLAN, FAIRFAX- JERSEY CR UNIT: BPU Floodwall Atl 1 and JC Sheetpile Wall Alt 4		*$ 15,684.0*	*$ 1,030.0*	*$ 16,714.0*	*$ 969.1*	*$ 4.0*	-	*$ 973.1*	*$ 11,667.8*	*12.0*	*$ 10,694.7*	*$ 4,416.2*	*no chg*		*0.99*		
NORTH KANSAS CITY UNIT (2 sites)	$ 11,434.7													0.85			
Harlem Site																	
Alt 1, Flood Fight**																	
Alt 2, Landside Seepage Berm***		$ 5,910.0	$ 616.4	$ 6,526.4	$ 378.4	$ 1.0	-	$ 379.4	$ 3,781.4	10.0	$ 3,402.0	$ 7,653.3	no chg		0.93		
Alt 3, Buried Collector System		*$ 1,455.0*	*$ 68.0*	*$ 1,523.0*	*$ 88.3*	*$ 1.5*	-	*$ 89.8*	*$ 3,781.4*	*42.1*	*$ 3,691.6*	*$ 7,653.3*	*no chg*		*0.93*		
Alt 4, Pressure Relief Wells		$ 1,992.0	$ 81.0	$ 2,073.0	$ 120.2	$ 25.8	-	$ 146.0	$ 3,781.4	25.9	$ 3,635.4	$ 7,653.3	no chg		0.93		
National Starch Site																	
Alt 1, Relief Well System		*$ 7,063.0*	*$ 479.5*	*$ 7,542.5*	*$ 437.3*	*$ 31.8*	-	*$ 469.1*	*$ 1,657.6*	*3.5*	*$ 1,188.5*	*$ 9,777.0*	*no chg*		*0.88*		
NED PLAN, NORTH KANSAS CITY UNIT: Harlem Alt 3 and Nat'l Starch Alt 1		*$ 8,518.0*	*$ 547.5*	*$ 9,065.5*	*$ 525.6*	*$ 33.3*	-	*$ 558.9*	*$ 6,663.9*	*11.9*	*$ 6,105.0*	*$ 4,770.8*	*no chg*		*0.98*		
EAST BOTTOMS UNIT (confluence site)	$ 7,130.4													0.96			
Alt 1, Flood Fight**																	
Alt 2 Sheetpile Wall		$ 12,849.0	$ 390.0	$ 13,239.0	$ 767.6	$ 2.0	-	$ 769.6	$ 4,232.7	5.5	$ 3,463.1	$ 2,897.7	no chg		0.998		
Alt 3 Slurry Cut-Off Wall		$ 3,416.0	$ 106.8	$ 3,522.8	$ 204.3	$ 2.0	-	$ 206.3	$ 4,232.7	20.5	$ 4,026.4	$ 2,897.7	no chg		0.998		
NED PLAN E Bottoms: Alt 4, Pressure Relief Wells		*$ 1,346.0*	*$ 50.7*	*$ 1,396.7*	*$ 81.0*	*$ 24.8*	-	*$ 105.8*	*$ 4,232.7*	*40.0*	*$ 4,126.9*	*$ 2,897.7*	*no chg*		*0.998*		

NOTES:

* Includes PED, LERRD and Construction costs; Argentine Unit: Project First Cost shown includes non-creditable relocations that are not cost shared features of the project; Fairfax-JC Unit: JC Sheetpile Wall & Wharf Area Project First Cost shown includes wharf area cost; however, wharf area is not a cost shared feature of the project.

** The true costs of a flood fight alternative are difficult to determine. A flood fight offers no guarantees of success and necessarily incurs tremendous costs for emergency services and floodplain evacuation. Because of the massive level of industrial, commercial, public and other investment located in the Kansas Citys levee units, the potential for an entire unit to flood if the levee/floodwall were undercut or failed, and the resulting massive damages that would occur in the unit, it is unlikely that a flood fight alternative would be considered an acceptable and viable alternative to be carried forward for further refinement.

*** Harlem Site Alt 2 Landside Seepage Berm does not include costs for relocating residents or utilities relocations.

**** OMRR&R cost shown is the estimated net increase in sponsor OMRR&R costs with the implementation of the proposed work.

***** Total Annual Cost includes Other Direct/Associated Costs (induced flood damages and privately owned pump station increase in O&M)

****** Ref Argentine "n500+3 raise" selection as the NED plan for the Argentine unit: IAW with HQUSACE Policy, when two alternatives provide nearly the same maximum NED benefits (in this case the n500+3 and the nom500+5), then the lesser cost alternative (of the two) is deemed the NED alternative.

******* Benefits of the separable features/sites in the Fairfax-Jersey Creek and North Kansas City Units are not additive in determining benefits for the total project in each unit. Benefits are determined in the HEC-FDA model based on residual risk considerations and a combined (not additive) probability of failure analysis that considers that one feature/site could fail, or both features/sites could fail, flooding the same structures.

EXHIBIT #11: P&G SYSTEM OF ACCOUNTS--EVALUATION TABLE for KANSAS CITYS Aug-06

Note regarding the sites chosen for display: Sites chosen for display here are those with new authorization requirements. These three sites are categorized as new work and fall under the P&G system of accounts evaluation practices as it relates to planning new projects. The remaining three sites (NKC Harlem, NKC National Starch area, and Fairfax BPU floodwall) are categorized as design deficiency corrections to be undertaken with existing authority (see Interim Feasibility Report section titled "Work Categorization").

	ARGENTINE UNIT					FAIRFAX-JERSEY CREEK SHEETPILE WALL				EAST BOTTOMS UNDERSEEPAGE CONTROL MEASURES			
	Without Project (WO)	**Evaluation and Characterization of the Alternatives**				**Without Project (WO)**	**Evaluation and Characterization of the Alternatives**			**Without Project (WO)**	**Evaluation and Characterization of the Alternatives**		
1. PLAN DESCRIPTION	No Federal Action Alternative	Arg 1: Nominal 500+0 raise (TOL 778.24 at index pt)	Arg 2: Nominal 500+3 Raise (TOL 781.24 at index pt)	Arg 3: Nominal 500+5 Raise (TOL 783.24 at index pt)	Arg 4: No Raise, Pump Sta & Earthwork	No Federal Action Alternative	Jersey Cr Alt 2, New Closed Cell Sheetpile Wall	Jersey Cr Alt 3, New Wall, Auger Cast Piles & Tiebacks	Jersey Cr Alt 4, New Open Cell Sheetpile Wall	No Federal Action Alternative	Blue R. Confluence Site Alt 2, Sheetpile Wall	Blue R. Confluence Site Alt 3, Slurry Cut-Off Wall	Blue R. Confluence Site, Alt 4, Pressure Relief Wells
2. IMPACT ASSESSMENT													
A. Implementation Impacts													
* Ranking: 1 = Highest rank or can be considered "best" among the alternatives													
Real Estate (RE) Considerations		typical RE requirements -routine acquisition	typical RE requirements -routine acquisition	substantial RR coord & private RE impacts	a few small RE requirements		few if any RE requirements	few if any RE requirements	few if any RE requirements		few if any RE requirements	few if any RE requirements	few if any RE requirements
Residual Damage Characterization	Residual Damages Remain significant	Significantly reduced	Significantly reduced	Significantly reduced	Reduced	Residual Damages Remain significant	Significantly reduced	Significantly reduced	Significantly reduced	Residual Damages Remain significant	Significantly reduced	Significantly reduced	Significantly reduced
Residual Damage Ranking	5	3	2	1	4	4	1 (same for all alt)	1 (same for all alt)	1 (same for all alt)	4	1 (same for all alt)	1 (same for all alt)	1 (same for all alt)
B. National Economic Development (NED)													
Project Cost	NA	2	3	4	1	NA	3	2	1	NA	3	2	1
Total Average Annual Cost	NA	2	3	4	1	NA	3	2	1	NA	3	2	1
Other Direct Costs Including Induced Damages	NA	2	3	4	1	NA	NA	NA	NA	NA	NA	NA	NA
Average Annual Benefits	NA	3	2	1	4	NA	1 (same for all alt)	1 (same for all alt)	1 (same for all alt)	NA	1 (same for all alt)	1 (same for all alt)	1 (same for all alt)
Benefit to Cost Ratio	NA	*7.3*	*4.9*	*4.1*	*13.9*	NA	*15.6*	*17.6*	*19.8*	NA	*5.5*	*20.5*	*40.0*
B/C Ranking	NA	2	3	4	1	NA	3	2	1	NA	3	2	1
Average Annual Net Benefits	NA	*$13,507.6*	*$14,025.5*	*$14,124.2*	*$12,479.2*	NA	*$9,744.2*	*$9,819.9*	*$9,884.4*	NA	*$3,463.1*	*$4,026.4*	*$4,126.9*
Net Benefits Ranking		2	1 (+3 & +5 Tie)	1 (+3 & +5 Tie)	3		3	2	1		3	2	1
C. Regional Economic Development (RED)		*See Footnote*	*See Footnote*	*See Footnote*	*See Footnote*		*See Footnote*	*See Footnote*	*See Footnote*		*See Footnote*	*See Footnote*	*See Footnote*
D. Environmental Quality (EQ)													
Air Quality	no immediate impact	Temporary impacts during construction	Temporary impacts during construction	Temporary impacts during construction	Temporary impacts during construction	no immediate impact	Temporary impacts during construction	Temporary impacts during construction	Temporary impacts during construction	no immediate impact	Temporary impacts during construction	Temporary impacts during construction	Temporary impacts during construction
Water Quality	no immediate impact possible adverse future impacts	Essentially no impact	Essentially no impact	Essentially no impact	Essentially no impact	no immediate impact possible adverse future impacts	Essentially no impact	Essentially no impact	Essentially no impact	no immediate impact possible adverse future impacts	Essentially no impact	Essentially no impact	Essentially no impact
Threatened & Endangered Species	no immediate impact	No impacts	No impacts	No impacts	No impacts	no immediate impact	No impacts	No impacts	No impacts	no immediate impact	No impacts	No impacts	No impacts
Aquatic Habitat	no immediate impact possible adverse future impacts	Essentially no impact	Essentially no impact	Essentially no impact	Essentially no impact	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts
Wildlife Habitat	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts	No impacts	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts
Wetlands	no immediate impact possible adverse future impacts	Very minor impacts to be mitigated	Very minor impacts to be mitigated	Very minor impacts to be mitigated	Very minor impacts to be mitigated	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts	no immediate impact possible adverse future impacts	No impacts	No impacts	No impacts
Vegetation	no immediate impact possible adverse future impacts	Very minor impacts to be mitigated Beneficial: Preserves 185 acres riparian habitat	Very minor impacts to be mitigated Beneficial: Preserves 185 acres riparian habitat	Very minor impacts to be mitigated Beneficial: Preserves 185 acres riparian habitat	Very minor impacts to be mitigated	no immediate impact possible adverse future impacts	Temporary construction impacts	Temporary construction impacts	Temporary construction impacts	no immediate impact possible adverse future impacts	Temporary construction impacts	Temporary construction impacts	Temporary construction impacts
Contaminated Sites (HTRW & non-CERCLA Regulated wastes)	no immediate impact possible major adverse future impacts	Avoidance measures adopted; some nonCERCLA cleanup	Avoidance measures adopted; some nonCERCLA cleanup	Avoidance measures adopted; some nonCERCLA cleanup	Avoidance measures adopted; some nonCERCLA cleanup	no immediate impact	No impacts	No impacts	No impacts	no immediate impact possible major adverse future impacts	Avoidance measures adopted	Avoidance measures adopted	Avoidance measures adopted
Cultural Resources	no immediate impact	No impacts	No impacts	No impacts	No impacts	no immediate impact	No impacts	No impacts	No impacts		No impacts	No impacts	No impacts
E. Other Social Effects (OSE)													
Life, Health and Safety	no improvement	Major improvements	Major improvements	Major improvements	Major improvements		Major improvements	Major improvements	Major improvements		Major improvements	Major improvements	Major improvements
Community Cohesion	no improvement	Major improvements	Major improvements	Major improvements	Major improvements		Major improvements	Major improvements	Major improvements		Major improvements	Major improvements	Major improvements
Socio-economics		Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions		Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions		Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions	Contributes to stable/ improved socio-economic conditions
3. PLAN EVALUATION													
A. Contribution to Planning Objectives	does not meet planning objectives	very good	very good	very good	fair	does not meet planning objectives	+	+	+	does not meet planning objectives	+	+	+
B. Response to Planning Constraints													
(1) Financial Capability of Local Partners to Cost share Construction	NA	good	adequate	unknown	good	NA	good	good	good	NA	adequate	good	good
(2) Institutional Acceptability	does not meet constraints	good	adequate	marginal	good	does not meet constraints	good	good	good	does not meet constraints	adequate	good	good
C. Response to Evaluation Criteria													
Coding: + = positive (desirable) implications based on the specific screening criteria; - = negative (undesirable) implications based on the specific screening criteria; / = neutral implications based on the specific screening criteria													
(1) Completeness		+	+	+	/		+	+	+		+	+	+
(2) Acceptability		+	+	+	+		+	+	+		+	/	+
(3) Effectiveness		+	+	+	+		+	+	+		+	+	+
(4) Efficiency		+	+	+	+		+	-	+		-	/	+

** *RED, All Alternatives:* Reduced flooding would enhance stability in employment in the Unit with potential for additional permanent employment opportunities; project construction would provide minor, short-term increase in construction employment; temporary increase in sales tax revenues during construction; property values would remain stable or improve, thereby increasing the local tax base; reductions in income attributable to flood damages, wage losses, traffic disruption costs, floodfight emergency expenditures. No known adverse impacts

EXHIBIT # 12: ADDITIONAL DESIGN AND CONSTRUCTION CONSIDERATIONS

Additional descriptions of site-specific design and construction requirements for implementation of the Recommended Plan are listed below.

Argentine Levee Raise Design and Construction Considerations

Argentine Levee Raise: General Design and Construction Factors. In general, the following two factors will affect design and construction along several areas of the levee raise.

- Several areas along the Argentine levee were identified as Hazardous, Toxic, or Radiological Waste (HTRW) sites. A section within the main feasibility report describes HTRW considerations of the Recommended Plan. Design and construction procedures need to recognize these sites and adapt accordingly. Construction cannot normally occur on top of contaminated soil.

- The Recommended Plan for the Argentine levee raise involves no permanent impact to existing railroad tracks, but the design and construction in for all areas with adjacent railroad tracks does require coordination with the railroads. Trains may need to be temporarily re-scheduled so as to allow movement of construction equipment into and out of the construction area.

Argentine I-wall Construction. The pre-construction coordination should include careful planning sessions where the I-wall procedures are sequenced and scheduled to avoid undue delays with an open levee crown. During I-wall construction, the levee crown is removed along with any rip rap cover. The I-wall installation proceeds and then the levee crown is rebuilt as soon as practical.

Argentine Floodwall Extending East of Station 276+70. This major floodwall is adjacent to railroad tracks all the way from Sta 276+70 to Station 287+92 (about 1200 feet). The floodwalls are inverted cantilever T-walls on spread footing foundations. A stop log closure structure continues to station 288+57, crossing the multiple lines of Santa Fe Railroad track. The Recommended Plan requires floodwall and stoplog replacement. All of this work requires close coordination with the railroad to prevent rail downtime. Access and available staging need careful planning due to the close proximity of the tracks. Equipment is likely to enter the area from the upstream end. Work is likely to proceed from downstream to upstream.

Argentine Floodwall Sta 251+65 to Sta 253+92 and Argentine Main Pump Station. A floodwall protecting the Argentine main pump station is located from Sta 251+65 to Sta 253+92 (about 225 feet). The Recommended Plan requires floodwall replacement. Excavation and removal of the existing floodwall begins the construction sequence. During removal, deep excavation is needed where the earthen levee currently meets the floodwall (on both sides). The primary consideration for this site is high-water contingencies (such as a stockpile of impervious material and backfilling equipment available in the event of high water). Petroleum-based (non-CERCLA) contamination is present in this area and the project estimate anticipates contaminated soil and special disposal requirements. Clean fill material is used for backfill. Handling of contaminated groundwater is not required as the groundwater table is normally below the planned excavation depth.

Argentine Strong Ave. Pump Station and Outlet Box at Station 273+41. The construction procedure for strengthening of the Strong Ave. pump station uses a steel pilaster and braced strut design for the foundation walls, along with a thickened reinforced slab to address floor strength and station uplift concerns. A jacked-in steel pipe liner is used to strengthen the existing outlet culvert. Accurate alignment and set-up of the jacking operation is crucial. Working areas within the pump station are restricted in size and the construction schedule should anticipate some typical close quarter work..

Argentine Utility Crossings. Utilities crossing the Argentine Unit were studied to estimate the costs for relocation or removal of (functioning or abandoned) utilities, and for the real estate implications related to preliminary compensability determinations. As a general rule, pressure pipelines passing through or under the levee are generally relocated over the raised levee. An additional amount of earth cover tops off the utility lines and the resulting “mound” is sloped on each side to allow vehicular transverse. Normally these utility lines are hot-tapped thus maintaining service to customers during construction.

Argentine Unit Bridges and Roadways. The Recommended Plan does not require any bridge superstructure modifications, nor does the Recommended Plan require any road realignments. Transportation of levee raise materials may at times increase traffic along nearby roadways but this area is industrial and truck traffic is common.

The final grade and slope on the raised top-of-levee access road needs close coordination with the sponsor. The raised top-of-levee road incorporates up-and-over utility crossings under the Recommended Plan. The design for these crossings points and the amount of roadway cover should allow vehicular traffic (such as passenger cars and trucks) to traverse the crossings with relative ease. The design of the top-of-levee road may need some realignment to maintain required minimum clearance under the I-635 bridge structure.

East Bottoms Missouri and Blue Confluence Area Relief Well Installation

The Recommended Plan provides for installation of a series of relief wells in the East Bottoms levee unit from approximately Station 403+00 to Station 420+00. While relief well installation is relatively standard practice, some well flow-testing during the design phase is needed to establish the expected capacity and flow characteristics for final well design.

During design phase flow-testing and during construction, it is important to avoid any unintended variance from the designated well locations. The Recommended Plan carefully avoids contaminated Solid Waste Management Unit (SWMU) sites. Adequate coordination with the adjacent industrial facilities manager is needed if fences require relocation (which may be necessary for large equipment access). The construction contract must contain adequate security coordination requirements. Construction procedures must recognize and include avoidance or protection from the power lines in the immediate area. Underground utilities clearances are needed per normal operating procedure, but problems with underground utilities conflicts are not expected. Staging area may need to be located about 2,000 feet to the west of the work area as the adjacent industrial site is secure and has no available space for staging.

Fairfax-Jersey Creek Unit, Fairfax-BPU Floodwall Modifications

The Recommended Plan for the Fairfax-BPU Floodwall (Sta 287+86 to Sta 302+32) provides for strengthening of the floodwall pile foundation. The proposed work includes extending the pile cap and adding an additional fourth row of auger-cast piles along the entire floodwall. The feasibility level pile design uses 50-ft deep, 24” diameter auger cast piles at seven foot on center. During the design phase, a more detailed design is needed for the exact sizing of the fourth row of piles. The piles are enclosed within a new extended pile cap which is connected into the existing pile cap. A buttress is installed over each new pile to transfer load from the wall into the additional piles.

Access must consider BPU power plant operations. Prior to construction contract award, the project team must coordinate delivery routes and acceptable periods for deliveries, acceptable locations for construction trailers, general staging and storage. The location of railroad tracks (these are short haul tracks that move coal within the power plant yard) need consideration. The project estimate includes protection (or temporary removal and reinstallation) of certain tracks during construction.

The BPU work site includes a 500-foot reach along the floodwall containing numerous underground utilities including major water intake lines for the power plant. Carefully designed and constructed floodwall modifications in this utilities area are necessary to prevent disruption of plant operations. The critical nature of these utility lines require detailed utility locations efforts and clearances beyond the normal procedures. Construction management must closely and continually monitor the excavation and pile installation process within this utilities area.

An old Kansas City, Kansas waterworks pump station with potentially historic connotations needs special attention. The recommended floodwall modifications are within 30 to 50 feet of the old pump station. The Recommended Plan leaves the visible pump station building intact. However, to reduce the potential for underseepage failure, the pump station basement is filled with sand or flow-able fill material. The foundation slab requires perforation and all (abandoned) pumping equipment are removed. Pipes connected to the old pump station are grouted full.

Fairfax-Jersey Creek Unit, Jersey Creek Sheetpile Wall Reconstruction

This sheetpile retaining wall structure is located between Sta 15+70 to Sta 29+98 and provides stability for the foreshore bank situated below the existing levee and I-wall. The recommend plan includes reconstruction of this sheetpile wall due to general age-related degradation. Reconstruction uses a driven open-cell sheet pile system constructed landside of the existing sheetpile wall. It is expected that the construction of the new wall will require floating plant (barge with crane) positioned in the Missouri River. Landside access to the area is available and should well complement the floating plant installation.

The design and construction of the sheetpile wall should aim to leave as much of the current wall in-place as possible. This involves cutting through, pulling, and otherwise removing minimum size sections of the existing wall so as to form the open gaps necessary to drive the new sheetpile tiebacks in the open-cell configuration. Design and preconstruction planning must adequately consider the exact manner and locations where the old sections are to be removed.

The design must consider the manner in which the new sheetpile wall will terminate adjacent to each end of the wharf area (the wharf area reconstruction is not part of the Federal construction project as it is planned for local accomplishment). It may be best to design the new sheetpile wall cells to terminate independently of the wharf as the schedule for local wharf reconstruction cannot be directed by the Corps of Engineers.

North Kansas City Unit - Harlem Area Buried Collector (Sta 210+00 to Sta 240+00)

A sewage force main crosses along and near the landward levee toe in the Harlem area. The sewer main is not scheduled for relocation. Precautions are necessary to prevent inadvertent damage or dislocation of the main. Both the sewer main and a row of nearby power poles may require temporary bracing. The project coordination team should select the construction staging area with consideration of limiting traffic impacts to the nearby businesses and residences.

North Kansas City Unit - National Starch Area Relief Well System (Sta 259+00 to Sta 271+00).

The Recommended Plan provides for a relief well system and a small pump station to control underseepage and reduce uplift at the landward toe of the existing levee in the National Starch Area. Access is via top-of-levee road or through industrial site. Coordination with the industrial facility manager for appropriate security measures is necessary at this work site. This area is somewhat remote from paved roads and the trafficability of, and damage to, the top-of-levee access road should be monitored. It may be possible to locate the construction staging area within the adjacent industrial site if appropriate permission and temporary easements are granted.

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EXHIBIT #13: INDUCED DAMAGES MFR

CENWK-EC-HH 27 Apr 2006

MEMORANDUM FOR RECORD

SUBJECT: Kansas Citys Feasibility Study
Argentine Levee Raise Induced Damages

1. Background. As a result of the Flood of 1993 the performance characteristics of the Kansas Citys Units were questioned. A feasibility study was begun to identify any deficiencies in the Kansas Citys system and determine if it is economically feasible to improve these levees. The Missouri River levees were found to provide adequate protection for the 0.2% chance event, but it was discovered that the performance of the Kansas River Units was lower than expected. A levee raise of the Argentine Unit has been identified as a proposed alternative in this feasibility study.

2. Problem. The feasibility study is examining the alternatives of raising the Argentine Unit (RM 4.28 to RM 9.82) along the Kansas River. Three alternatives are being examined: a raise to the nominal 0.2% chance flood event (500+0 alternative), a raise to the nominal 0.2% chance flood event plus 3.0-feet (500+3 alternative), and a raise to the nominal 0.2% chance flood event plus 5.0-feet (500+5 alternative). The feasibility study requires the analysis of any induced damages due to raises in the water surface profile caused by raises of the studied levee unit. The existing conditions HEC-RAS model of the Kansas River assumes a confined flow model with any flow behind the levee being considered ineffective. Since the interior protected area is considered ineffective in the event of overtopping, the HEC-RAS model does not reflect any change in water surface profiles due to a proposed levee raise. To identify any possible impacts upstream and opposite of the Argentine unit, limited conveyance in the protected area due to overtopping was investigated for this analysis. HEC-RAS is a steady state flow model, calculating the water surface profiles in a subcritical channel, such as the Kansas River, using backwater methodology from downstream to upstream. Therefore, HEC-RAS did not identify any impacts to the downstream levee units (Armourdale and Central Industrial District). The only method for the Argentine raise to impact downstream units is if additional flow is forced downstream due to the raise. This can only occur if the failure of the Argentine Unit in the existing conditions is temporarily reducing downstream flows as the flow through the levee breach fills the protected area and this breach flow is removed as the levee is raised.

3. Purpose of this MFR. The purpose of this MFR is to document the procedures used to estimate the induced damages upstream, opposite, and downstream of a proposed Argentine raise.

4. Outline of Study Process. A calibrated HEC-RAS model was developed for the existing conditions along the studied reach of the Kansas River as part of the Kansas Citys Feasibility Study. This existing conditions model has been peer reviewed and

through ITR. The existing conditions HEC-RAS model will be used as the basis for this analysis. This memorandum outlines the procedure used to estimate the induced damages due to the Argentine Levee raise. The procedure consisted of the following steps:

4.1 Areas downstream of the Argentine Unit

a) The flow that initiates overtopping was analyzed for the existing condition and each of the three studied alternative raises. The critical overtopping point was identified along the existing Argentine Unit at approximately levee station 240+00. This point begins overtopping at a flow of 317,000cfs. By definition the 500+0 alternative begins overtopping at the 0.2% chance event (341,000 cfs). The 500+3 and 500+5 levee raises were plotted versus the water surface profiles for the studied events. The 500+3 overtops in an event just greater than the 0.133% (750-yr event) chance event and the 500+5 alternative overtops in an event just greater than the 0.10% chance event (1000-yr event) (See Plate 1). The overtopping flow was found by interpolating between the flows associated with each frequency event bracketing the top of levee for both the 500+3 and 500+5 alternatives. The overtopping flows were found to be 372,000 cfs and 391,000 cfs for the 500+3 and 500+5 alternatives, respectively.

b) The assumption was made that overtopping initiates a levee breach which will flow at a uniform flow rate until the protected area is filled from the breach flow. The interior area will fill to an elevation equal to the lowest top of levee elevation at the downstream end of the unit (elevation 770.37) when flow would begin re-entering the Kansas River over the top of the levee. A 5-foot interval aerial contour map, supplied by the Unified Government of Wyandotte County and Kansas City, Kansas, was used for the calculation of interior volume. The following table lists the results of the analysis of the volume interior to the Argentine Levee Unit.

Table 1. Argentine Levee Interior Volume

Elevation (ft above msl)	Contour Area (acre)	Volume Below Contour (ac-ft)
752	26.6	0
755	238.7	398
760	664.5	2,258
765	1493.3	5,394
770	1916.9	9,156
	Total Volume =	**17,206**

c) To calculate the possible flow reduction due to breach flow filling the Argentine protected area a flood hydrograph needed to be developed for the Kansas River. Gage records were used for developing the peak flows associated with the various frequency events in this feasibility study and the Upper Mississippi River System Flow Frequency Study (UMRSFFS) completed by the Kansas City District in

2001. There are no hydrographs associated with these peak flows as the modeling of the Kansas River has been steady state. The synthetic hydrograph for this analysis was based on a combination of the flood hydrograph taken from daily flow records taken at the Desoto gage during the 1951 flood event along the Kansas River and hourly flow records from the 1993 flood event taken at the Hannibal Bridge on the Missouri River. The 1951 flood event along the Kansas River had a peak flow of 486,000 cfs which is greater than the 0.067% chance event used in this study of 417,000 cfs. This flow was prior to reservoir regulation of the Kansas River basin which has greatly reduced the peak flows seen in the Kansas River and the shape of the flood hydrograph. Therefore, this hydrograph was not seen as typical of any future floods along the Kansas River. The largest discharge in the Kansas River since the 1951 flood is the 1993 flood with a peak discharge of 170,000 cfs. This discharge is between a 5% (150,000 cfs) and 2% (202,000 cfs) chance event along the Kansas River as calculated in the UMRSFFS. Since this study is analyzing floods greater than the 0.2% chance event, it was deemed that extrapolating a hydrograph from this frequent of an event to a low frequency event (0.2% chance) would distort the likely shape of the low frequency event hydrograph. Therefore, the hydrograph from the Hannibal Bridge along the Missouri River was seen as representative of a flood of this magnitude as the peak 1993 flow was 541,000 cfs (just greater than the 0.2% chance event along the Missouri River downstream of the Kansas River of 530,000 cfs). Since the Missouri River basin is also subject to reservoir control it was assumed that the hydrograph from the 1993 flood event along the Missouri River could be representative of a 500-yr hydrograph along the Kansas River. The 1951 Kansas River and 1993 Missouri River hydrographs were scaled to match the 0.2% chance flood peak of 341,000 cfs on the Kansas River. The peaks of these scaled hydrographs were then overlain with the rising limb and falling limb of the synthetic hydrograph being the average of the 1951 Kansas River hydrograph and 1993 Missouri River hydrograph at a given time before or after the peak (See Plate 2). This synthetic hydrograph shape was then scaled to match the peak flow of each frequency event to develop a hydrograph for each studied event.

d) It was assumed that a breach of constant flow would occur at the time of overtopping. The point on the rising limb of the 500-yr hydrograph when 317,000 cfs was encountered initiated a breach. This breach was assumed to introduce a constant flow of 10,000 cfs into the protected area. At the assumed rate of 10,000 cfs of inflow, the interior volume of 17,206 ac-ft would fill in approximately 21 hours before the downstream end of the Argentine Unit would begin allowing flow to re-enter the Kansas River. During this period of filling, the peak flow in the Kansas River would be reduced by the flow entering the levee breach (See Plate 3). If the breach occurred on the rising limb at a time close enough to the peak of the hydrograph, the peak would be reduced due to the loss of flow into the Argentine interior. This process was done for each event where overtopping would occur (0.2%, 0.133%, 0.1%, 0.08%, and 0.067% chance events). The peak flow in the Kansas River was recorded. Due to uncertainty of the breach flow, a series of flows were analyzed assuming breach flows of 5,000 cfs, 10,000 cfs, 20,000 cfs, and 30,000 cfs. At a breach flow of 30,000 cfs, the interior of the Argentine Levee was filled prior to the peak of the 500-yr hydrograph, thus any greater breach flow would also fill prior to the peak of the hydrograph, having no impact on peak flows seen in the Kansas River.

e) This process was repeated for each levee raise alternative to determine the impact of breach flows on peak flows seen in the Kansas River. The different levee raises consisted of breaches occurring at different flows along the rising limb of the hydrograph based on the overtopping flow associated with each alternative. A matrix seen in Table 2 was created to identify the minimum flow for each frequency of flood event for each proposed alternative. It is evident that for the 0.2% chance (500-yr) in the existing condition a levee breach can reduce the peak flow in the Kansas River to 335,625 cfs. Each proposed alternative (500+0, 500+3, and 500+5) should not allow overtopping in the 0.2% chance (500-yr) event and therefore allow the full 341,000 cfs to pass downstream. This allows a potential increase of 5,375 cfs of the peak flow seen at the Armourdale and CID Kansas Units in the 0.2% chance (500-yr) event caused by the proposed raises. It is possible to show that peak flows can be reduced by the proposed alternatives in some instances, but these cases have been neglected. The heavy "stair-stepped" line in Table 2 shows the limits of induced damages possible by the proposed raises.

Table 2. Matrix of Possible Flows With Argentine Breach

Alternative	Breach Flow	Peak Flows Seen D/S of Argentine (cfs)				
		500-yr	750-yr	1000-yr	1250-yr	1500-yr
EC Flow	---	341,000	367,000	388,000	403,000	417,000
No Raise	5k Breach	336,000	**362,000**	**383,000**	398,000	412,000
	10k Breach	**335,625**	367,000	388,000	403,000	417,000
	20k Breach	341,000	367,000	388,000	403,000	417,000
	30k Breach	341,000	367,000	388,000	403,000	417,000
500-yr Raise	5k Breach	341,000	362,000	383,000	398,000	412,000
	10k Breach	341,000	359,287	388,000	403,000	417,000
	20k Breach	341,000	367,000	388,000	403,000	417,000
	30k Breach	341,000	367,000	388,000	403,000	417,000
500-yr + 3' Raise	5k Breach	341,000	367,000	383,000	398,000	412,000
	10k Breach	341,000	367,000	378,000	398,765	417,000
	20k Breach	341,000	367,000	385,961	403,000	417,000
	30k Breach	341,000	367,000	388,000	403,000	417,000
500-yr + 5' Raise	5k Breach	341,000	367,000	388,000	398,000	412,000
	10k Breach	341,000	367,000	388,000	393,000	407,000
	20k Breach	341,000	367,000	388,000	394,530	417,000
	30k Breach	341,000	367,000	388,000	400,883	417,000

The maximum possible increase in peak flow due to the various alternatives was chosen and is tabulated below:

Table 3. Increase in Flows Seen Downstream of Argentine

Alternative	Δ Peak Flows Seen D/S of Argentine (cfs)				
	500-yr	750-yr	1000-yr	1250-yr	1500-yr
500-yr Raise	5,375	0	0	0	0
500-yr + 3' Raise	5,375	5,000	0	0	0
500-yr + 5' Raise	5,375	5,000	5,000	0	0

f) These increases in flow are actually from the possibility of the existing conditions to reduce the peak flow as compared to the full peak being able to be conveyed downstream in the proposed raise alternatives. Therefore, in actuality the existing conditions flows could be less than the UMRSFFS peak flow for a given frequency event. However, the procedure outlined in this MFR is approximate and does not justify modifying existing conditions flows. To represent this possible increase in peak flows as induced damages, the Kansas River flows were modified in HEC-RAS to be the UMRSFFS peak flow for a given frequency event plus the delta Q between the raised alternative and existing conditions. The following is an example of the 0.2% chance (500-yr) flow used in the analysis of induced damages for the 500+0 raise alternative:

$$Q_{500\,induced} = Q_{500} + \Delta Q_{500}$$

$$346{,}375\,cfs = 341{,}000\,cfs + 5{,}375\,cfs$$

Table 4. Kansas River Induced Flows

Alternative	Induced Peak Flows Seen D/S of Argentine (cfs)				
	500-yr	750-yr	1000-yr	1250-yr	1500-yr
500-yr Raise	346,375	---	---	---	---
500-yr + 3' Raise	346,375	372,000	---	---	---
500-yr + 5' Raise	346,375	372,000	393,000	---	---

g) The increased flows were run in HEC-RAS to generate an estimated water surface showing maximum induced damages due to the proposed levee raises. This estimated water surface is compared to the future conditions without project water surface profiles to determine the magnitude of induced increases in the water surface for the Kansas River. The induced damages due the 0.2% chance (500-yr) event are identical for each proposed alternative. The induced damages due the 0.133% chance (750-yr) event occur for only the 500+3 and 500+5 alternatives and are identical for both. The induced damages due the 0.1% chance (1000-yr) event occur for only the 500+5 alternative.

h) The likely overtopping point as seen on Plate 1 is near River Mile 4.48. Therefore, the induced peak flows are applicable to Kansas River Miles 4.48 and below. However, backwater effects due to this increased downstream flow cause an increase in the water surface upstream of the breach location. Therefore, the induced water surface increase caused by the downstream analysis must be compared to that caused by the upstream and opposite of Argentine analysis, with the larger increase in water surface controlling for the HEC-FDA Induced Damages Analysis.

4.2 Areas upstream and opposite of the Argentine Unit

a) The future conditions without project were evaluated with flow behind the levee in the protected area. The protected area was set with a permanent ineffective flow area extending from the levee to the bluff line at an elevation two feet below the existing top of levee. This modification allowed the top two feet and above of protected area to convey flow in the event of overtopping. This ineffective flow area definition modeled the obstructions at the lower levels and the presence of the downstream end of the unit preventing conveyance of the full depth of the protected area.

b) The future conditions with project profiles allowing flow behind the levee were then modeled in the same manner, with the ineffective flow elevation being two feet below the proposed top of levee.

c) The deltas between the future conditions with project and without project water surface with protected area conveyance were then calculated to determine the impacts of the proposed projects on the water surface profiles.

d) The delta in water surface was then added to the design water surface profiles for the future conditions with project (confined profiles) to produce an induced damages profile for economic calculations.

e) The upstream and opposite induced damage water surface increases must be compared to the increases in water surface caused by the additional flow in the downstream analysis to determine which delta controls for the Kansas River above River Mile 4.48.

5. Results. The attached tables are a summation of the flood profiles generated in this HEC-RAS analysis and manipulated in an EXCEL spreadsheet. Table 5 displays the results of the HEC-RAS induced damages water surface increases in flood peaks for the n500+0 project alternative due to the downstream analysis described in Paragraph 4.1. Table 6 displays the results of the HEC-RAS induced damages water surface increases in flood peaks for the n500+3 project alternative due to the downstream analysis described in Paragraph 4.1. Table 7 displays the results of the HEC-RAS induced damages water surface increases in flood peaks for the n500+5 project alternative due to the downstream analysis described in Paragraph 4.1. The maximum downstream induced impact to the water surface profile is 0.50 ft seen near the downstream end of the Argentine Levee Unit. Table 8 displays the results of the HEC-RAS induced damages water surface increases for the n500+0 project alternative due to the upstream and opposite bank

analysis described in Paragraph 4.2. Table 9 displays the results of the HEC-RAS induced damages water surface increases for the n500+3 project alternative due to the upstream and opposite bank analysis described in Paragraph 4.2. Table 10 displays the results of the HEC-RAS induced damages water surface increases for the n500+5 project alternative due to the upstream and opposite bank analysis described in Paragraph 4.2. It should be noted that in all proposed raises no impacts were seen to the 0.5% and more frequent floods as they did not overtop the existing levee.

Eric Shumate, P.E.
Hydraulic Engineer

Plate 1. Argentine Levee Unit Water Surface Profiles and Proposed Raises

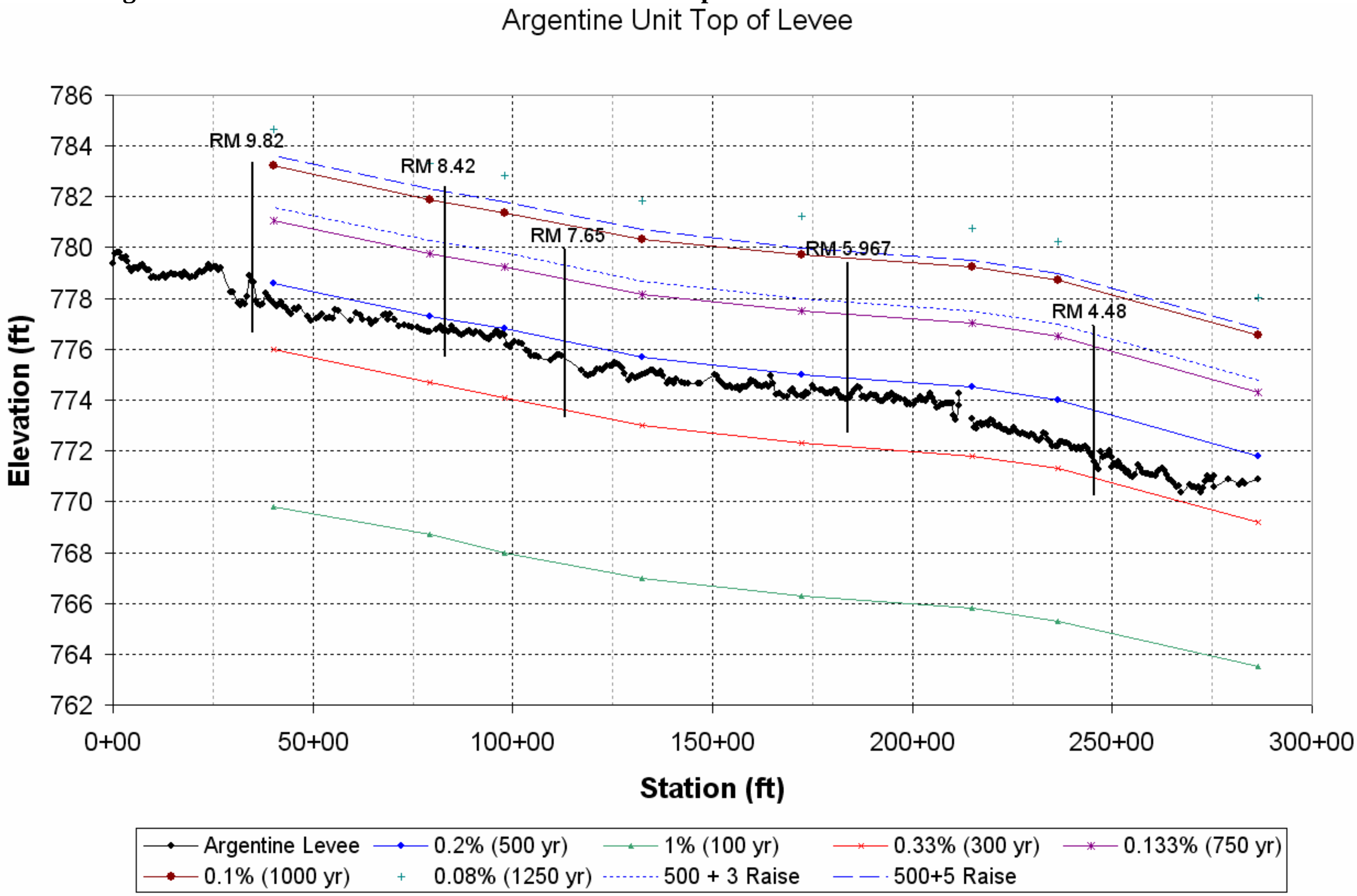

Plate 2. Kansas River Hypothetical Hydrograph

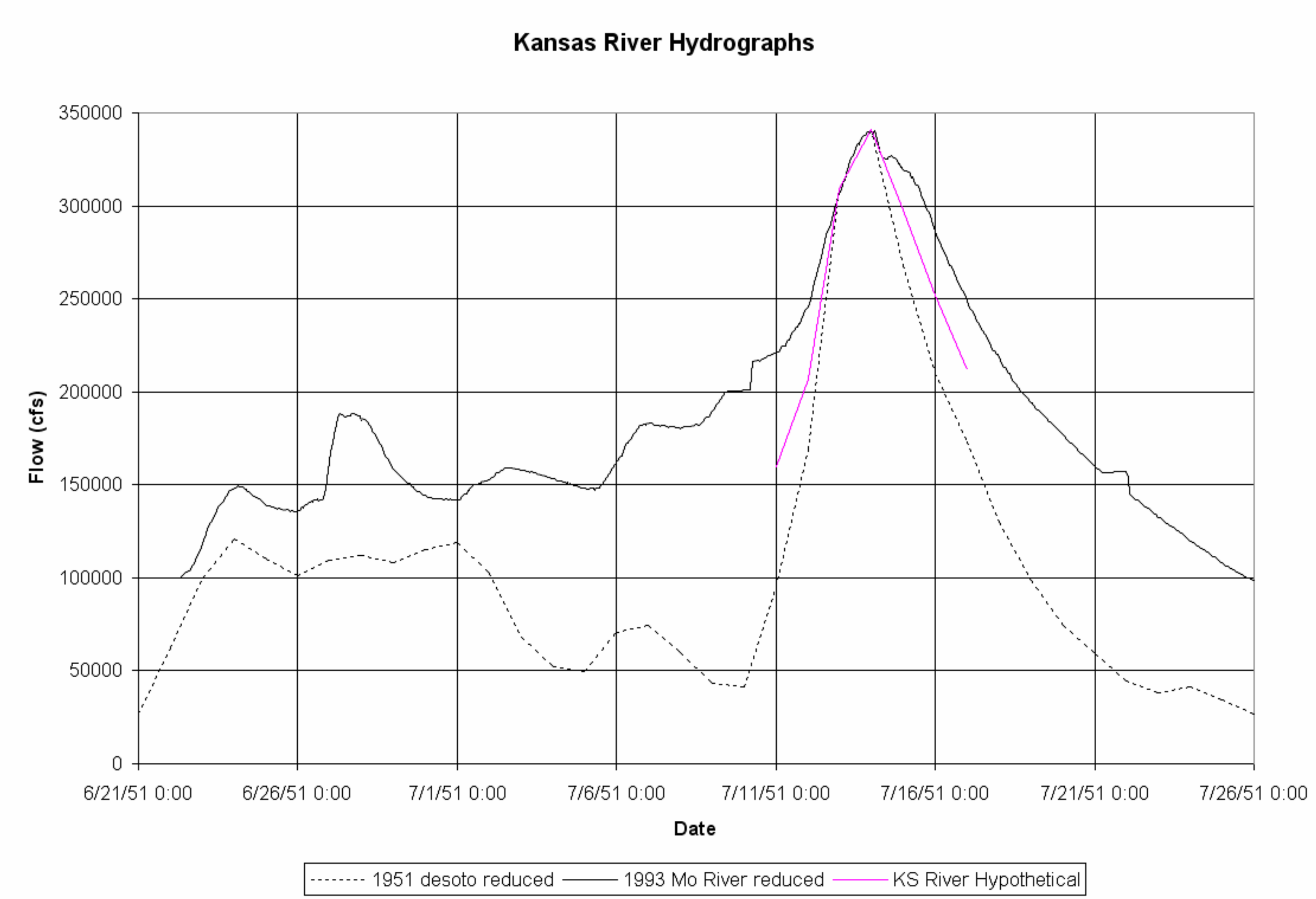

Plate 3. Sample Kansas River Hydrograph w/ Breach

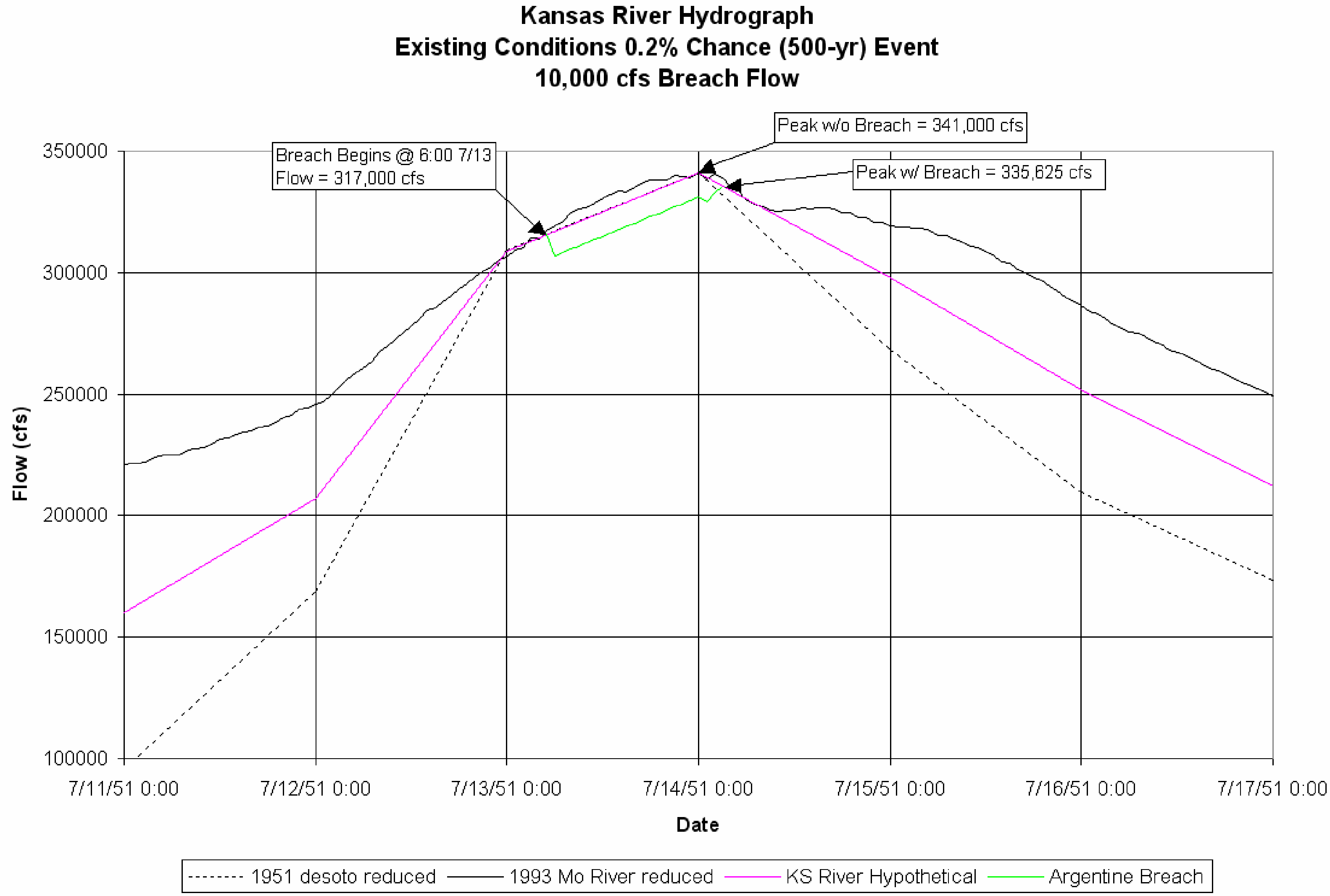

Table 5. Downstream Induced Damages Due to Argentine n500+0 Levee Raise

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
0.01	756.75	758.02	758.93	756.75	758.02	758.93	0.00	0.00	0.00
0.14	756.83	758.10	759.01	756.83	758.10	759.01	0.00	0.00	0.00
0.22	756.79	758.05	758.94	756.79	758.05	758.94	0.00	0.00	0.00
0.253	756.77	758.02	758.90	756.77	758.02	758.90	0.00	0.00	0.00
0.259	756.89	758.17	759.07	756.89	758.17	759.07	0.00	0.00	0.00
0.273704	757.62	759.02	760.01	757.62	759.02	760.01	0.00	0.00	0.00
0.285582	757.76	759.18	760.19	757.76	759.18	760.19	0.00	0.00	0.00
0.29746	757.77	759.19	760.21	757.77	759.19	760.21	0.00	0.00	0.00
0.309339	757.90	759.34	760.36	757.90	759.34	760.36	0.00	0.00	0.00
0.44	757.98	759.41	760.43	757.98	759.41	760.43	0.00	0.00	0.00
0.496	758.50	760.00	761.08	758.50	760.00	761.08	0.00	0.00	0.00
0.504	758.64	760.18	761.28	758.64	760.18	761.28	0.00	0.00	0.00
0.64	758.78	760.29	761.36	758.78	760.29	761.36	0.00	0.00	0.00
0.812	758.93	760.45	761.53	758.93	760.45	761.53	0.00	0.00	0.00
0.817	759.04	760.70	761.92	759.04	760.70	761.92	0.00	0.00	0.00
1.106	759.91	761.64	762.91	759.91	761.64	762.91	0.00	0.00	0.00
1.117	760.02	761.91	763.31	760.03	761.91	763.31	0.01	0.00	0.00
1.27	761.08	763.06	764.54	761.37	763.06	764.54	0.29	0.00	0.00
1.385	761.34	763.28	764.76	761.63	763.28	764.76	0.29	0.00	0.00
1.413	761.67	763.56	765.08	761.96	763.56	765.08	0.29	0.00	0.00
1.614	761.74	763.61	765.14	762.03	763.61	765.14	0.29	0.00	0.00
1.62401	762.23	764.21	765.93	762.55	764.21	765.93	0.32	0.00	0.00
1.6335	762.26	764.23	765.96	762.58	764.23	765.96	0.32	0.00	0.00
1.643	762.46	764.55	766.38	762.78	764.55	766.38	0.32	0.00	0.00
2.016	763.64	765.59	767.39	763.97	765.59	767.39	0.33	0.00	0.00
2.097	763.98	765.95	767.74	764.31	765.95	767.74	0.33	0.00	0.00
2.111	764.31	766.45	768.40	764.67	766.45	768.40	0.36	0.00	0.00
2.165	765.08	767.27	769.24	765.46	767.27	769.24	0.38	0.00	0.00
2.179	765.46	767.79	769.89	765.87	767.79	769.89	0.41	0.00	0.00

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
2.491	766.05	768.33	770.38	766.45	768.33	770.38	0.40	0.00	0.00
2.525	766.10	768.38	770.43	766.50	768.38	770.43	0.40	0.00	0.00
2.536	766.64	769.16	771.38	767.12	769.16	771.38	0.48	0.00	0.00
3.05	768.54	771.03	773.21	769.02	771.03	773.21	0.48	0.00	0.00
3.405	769.43	771.92	774.09	769.91	771.92	774.09	0.48	0.00	0.00
3.427	769.75	772.31	774.54	770.25	772.31	774.54	0.50	0.00	0.00
3.96	770.71	773.23	775.41	771.20	773.23	775.41	0.49	0.00	0.00
4.276	771.23	773.72	775.89	771.71	773.72	775.89	0.48	0.00	0.00
4.284	771.42	773.97	776.21	771.92	773.97	776.21	0.50	0.00	0.00
4.48	771.78	774.32	776.54	772.27	774.32	776.54	0.49	0.00	0.00
4.949	773.18	775.73	777.92	773.68	775.73	777.92	0.5	0.00	0.00
4.97	773.41	776.00	778.24	773.91	776.00	778.24	0.5	0.00	0.00
5.506	773.93	776.51	778.73	774.41	776.51	778.73	0.48	0.00	0.00
5.52	773.97	776.55	778.77	774.45	776.55	778.77	0.48	0.00	0.00
5.811	774.47	777.06	779.28	774.94	777.06	779.28	0.47	0.00	0.00
5.831	774.49	777.10	779.33	774.97	777.10	779.33	0.48	0.00	0.00
6.88	774.97	777.55	779.77	775.43	777.55	779.77	0.46	0.00	0.00
7.329	775.21	777.78	779.98	775.66	777.78	779.98	0.45	0.00	0.00
7.333	775.22	777.79	780.00	775.67	777.79	780.00	0.45	0.00	0.00
7.342	775.24	777.81	780.01	775.7	777.81	780.01	0.46	0.00	0.00
7.351	775.27	777.82	780.03	775.71	777.82	780.03	0.44	0.00	0.00
7.36	775.29	777.85	780.06	775.74	777.85	780.06	0.45	0.00	0.00
7.364	775.31	777.86	780.07	775.75	777.86	780.07	0.44	0.00	0.00
7.65	775.65	778.20	780.38	776.08	778.20	780.38	0.43	0.00	0.00
8.42	776.75	779.26	781.42	777.14	779.26	781.42	0.39	0.00	0.00
9.04	777.31	779.79	781.91	777.69	779.79	781.91	0.38	0.00	0.00
9.49	778.00	780.43	782.51	778.35	780.43	782.51	0.35	0.00	0.00
9.505	778.02	780.51	782.63	778.39	780.51	782.63	0.37	0.00	0.00
9.82	778.59	781.07	783.21	778.94	781.07	783.21	0.35	0.00	0.00
10.4	778.80	781.27	783.39	779.14	781.27	783.39	0.34	0.00	0.00
10.6	779.00	781.46	783.57	779.34	781.46	783.57	0.34	0.00	0.00
10.9	779.85	782.25	784.30	780.16	782.25	784.30	0.31	0.00	0.00

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
11.35	780.29	782.67	784.70	780.6	782.67	784.70	0.31	0.00	0.00
11.85	780.85	783.19	785.19	781.14	783.19	785.19	0.29	0.00	0.00
12.4	781.22	783.52	785.45	781.5	783.52	785.45	0.28	0.00	0.00
12.94	781.44	783.70	785.68	781.71	783.70	785.68	0.27	0.00	0.00
13.3	781.68	784.02	785.97	781.95	784.02	785.97	0.27	0.00	0.00
13.65	781.96	784.26	786.18	782.22	784.26	786.18	0.26	0.00	0.00
14.25	782.15	784.43	786.35	782.4	784.43	786.35	0.25	0.00	0.00
14.62	782.30	784.58	786.48	782.55	784.58	786.48	0.25	0.00	0.00

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

Table 6. Downstream Induced Damages Due to Argentine n500+3 Levee Raise

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
0.01	756.75	758.02	758.93	756.75	758.21	758.93	0.00	0.19	0.00
0.14	756.83	758.10	759.01	756.83	758.28	759.01	0.00	0.18	0.00
0.22	756.79	758.05	758.94	756.79	758.23	758.94	0.00	0.18	0.00
0.253	756.77	758.02	758.90	756.77	758.19	758.90	0.00	0.17	0.00
0.259	756.89	758.17	759.07	756.89	758.35	759.07	0.00	0.18	0.00
0.273704	757.62	759.02	760.01	757.62	759.21	760.01	0.00	0.19	0.00
0.285582	757.76	759.18	760.19	757.76	759.38	760.19	0.00	0.20	0.00
0.29746	757.77	759.19	760.21	757.77	759.40	760.21	0.00	0.21	0.00
0.309339	757.90	759.34	760.36	757.90	759.54	760.36	0.00	0.20	0.00
0.44	757.98	759.41	760.43	757.98	759.61	760.43	0.00	0.20	0.00
0.496	758.50	760.00	761.08	758.50	760.22	761.08	0.00	0.22	0.00
0.504	758.64	760.18	761.28	758.64	760.40	761.28	0.00	0.22	0.00
0.64	758.78	760.29	761.36	758.78	760.51	761.36	0.00	0.22	0.00
0.812	758.93	760.45	761.53	758.93	760.67	761.53	0.00	0.22	0.00
0.817	759.04	760.70	761.92	759.04	760.94	761.92	0.00	0.24	0.00
1.106	759.91	761.64	762.91	759.91	761.89	762.91	0.00	0.25	0.00
1.117	760.02	761.91	763.31	760.03	762.19	763.31	0.01	0.28	0.00
1.27	761.08	763.06	764.54	761.37	763.35	764.54	0.29	0.29	0.00
1.385	761.34	763.28	764.76	761.63	763.56	764.76	0.29	0.28	0.00
1.413	761.67	763.56	765.08	761.96	763.85	765.08	0.29	0.29	0.00
1.614	761.74	763.61	765.14	762.03	763.91	765.14	0.29	0.30	0.00
1.62401	762.23	764.21	765.93	762.55	764.53	765.93	0.32	0.32	0.00
1.6335	762.26	764.23	765.96	762.58	764.56	765.96	0.32	0.33	0.00
1.643	762.46	764.55	766.38	762.78	764.90	766.38	0.32	0.35	0.00
2.016	763.64	765.59	767.39	763.97	765.94	767.39	0.33	0.35	0.00
2.097	763.98	765.95	767.74	764.31	766.29	767.74	0.33	0.34	0.00
2.111	764.31	766.45	768.40	764.67	766.83	768.40	0.36	0.38	0.00
2.165	765.08	767.27	769.24	765.46	767.66	769.24	0.38	0.39	0.00
2.179	765.46	767.79	769.89	765.87	768.21	769.89	0.41	0.42	0.00

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
2.491	766.05	768.33	770.38	766.45	768.74	770.38	0.40	0.41	0.00
2.525	766.10	768.38	770.43	766.50	768.79	770.43	0.40	0.41	0.00
2.536	766.64	769.16	771.38	767.12	769.60	771.38	0.48	0.44	0.00
3.05	768.54	771.03	773.21	769.02	771.47	773.21	0.48	0.44	0.00
3.405	769.43	771.92	774.09	769.91	772.36	774.09	0.48	0.44	0.00
3.427	769.75	772.31	774.54	770.25	772.77	774.54	0.50	0.46	0.00
3.96	770.71	773.23	775.41	771.20	773.68	775.41	0.49	0.45	0.00
4.276	771.23	773.72	775.89	771.71	774.17	775.89	0.48	0.45	0.00
4.284	771.42	773.97	776.21	771.92	774.44	776.21	0.50	0.47	0.00
4.48	771.78	774.32	776.54	772.27	774.78	776.54	0.49	0.46	0.00
4.949	773.18	775.73	777.92	773.68	776.17	777.92	0.5	0.44	0.00
4.97	773.41	776.00	778.24	773.91	776.45	778.24	0.5	0.45	0.00
5.506	773.93	776.51	778.73	774.41	776.94	778.73	0.48	0.43	0.00
5.52	773.97	776.55	778.77	774.45	776.99	778.77	0.48	0.44	0.00
5.811	774.47	777.06	779.28	774.94	777.49	779.28	0.47	0.43	0.00
5.831	774.49	777.10	779.33	774.97	777.53	779.33	0.48	0.43	0.00
6.88	774.97	777.55	779.77	775.43	777.97	779.77	0.46	0.42	0.00
7.329	775.21	777.78	779.98	775.66	778.18	779.98	0.45	0.4	0.00
7.333	775.22	777.79	780.00	775.67	778.19	780.00	0.45	0.4	0.00
7.342	775.24	777.81	780.01	775.7	778.22	780.01	0.46	0.41	0.00
7.351	775.27	777.82	780.03	775.71	778.23	780.03	0.44	0.41	0.00
7.36	775.29	777.85	780.06	775.74	778.25	780.06	0.45	0.4	0.00
7.364	775.31	777.86	780.07	775.75	778.26	780.07	0.44	0.4	0.00
7.65	775.65	778.20	780.38	776.08	778.58	780.38	0.43	0.38	0.00
8.42	776.75	779.26	781.42	777.14	779.62	781.42	0.39	0.36	0.00
9.04	777.31	779.79	781.91	777.69	780.13	781.91	0.38	0.34	0.00
9.49	778.00	780.43	782.51	778.35	780.76	782.51	0.35	0.33	0.00
9.505	778.02	780.51	782.63	778.39	780.84	782.63	0.37	0.33	0.00
9.82	778.59	781.07	783.21	778.94	781.42	783.21	0.35	0.35	0.00
10.4	778.80	781.27	783.39	779.14	781.61	783.39	0.34	0.34	0.00
10.6	779.00	781.46	783.57	779.34	781.8	783.57	0.34	0.34	0.00
10.9	779.85	782.25	784.30	780.16	782.56	784.30	0.31	0.31	0.00

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
11.35	780.29	782.67	784.70	780.6	782.97	784.70	0.31	0.3	0.00
11.85	780.85	783.19	785.19	781.14	783.48	785.19	0.29	0.29	0.00
12.4	781.22	783.52	785.45	781.5	783.8	785.45	0.28	0.28	0.00
12.94	781.44	783.70	785.68	781.71	783.98	785.68	0.27	0.28	0.00
13.3	781.68	784.02	785.97	781.95	784.28	785.97	0.27	0.26	0.00
13.65	781.96	784.26	786.18	782.22	784.52	786.18	0.26	0.26	0.00
14.25	782.15	784.43	786.35	782.4	784.69	786.35	0.25	0.26	0.00
14.62	782.30	784.58	786.48	782.55	784.83	786.48	0.25	0.25	0.00

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

Table 7. Downstream Induced Damages Due to Argentine n500+5 Levee Raise

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
0.01	756.75	758.02	758.93	756.75	758.21	759.13	0.00	0.19	0.20
0.14	756.83	758.10	759.01	756.83	758.28	759.20	0.00	0.18	0.19
0.22	756.79	758.05	758.94	756.79	758.23	759.14	0.00	0.18	0.20
0.253	756.77	758.02	758.90	756.77	758.19	759.09	0.00	0.17	0.19
0.259	756.89	758.17	759.07	756.89	758.35	759.27	0.00	0.18	0.20
0.273704	757.62	759.02	760.01	757.62	759.21	760.22	0.00	0.19	0.21
0.285582	757.76	759.18	760.19	757.76	759.38	760.40	0.00	0.20	0.21
0.29746	757.77	759.19	760.21	757.77	759.40	760.42	0.00	0.21	0.21
0.309339	757.90	759.34	760.36	757.90	759.54	760.58	0.00	0.20	0.22
0.44	757.98	759.41	760.43	757.98	759.61	760.64	0.00	0.20	0.21
0.496	758.50	760.00	761.08	758.50	760.22	761.30	0.00	0.22	0.22
0.504	758.64	760.18	761.28	758.64	760.40	761.50	0.00	0.22	0.22
0.64	758.78	760.29	761.36	758.78	760.51	761.58	0.00	0.22	0.22
0.812	758.93	760.45	761.53	758.93	760.67	761.76	0.00	0.22	0.23
0.817	759.04	760.70	761.92	759.04	760.94	762.17	0.00	0.24	0.25
1.106	759.91	761.64	762.91	759.91	761.89	763.17	0.00	0.25	0.26
1.117	760.02	761.91	763.31	760.03	762.19	763.60	0.01	0.28	0.29
1.27	761.08	763.06	764.54	761.37	763.35	764.84	0.29	0.29	0.30
1.385	761.34	763.28	764.76	761.63	763.56	765.06	0.29	0.28	0.30
1.413	761.67	763.56	765.08	761.96	763.85	765.39	0.29	0.29	0.31
1.614	761.74	763.61	765.14	762.03	763.91	765.45	0.29	0.30	0.31
1.62401	762.23	764.21	765.93	762.55	764.53	766.29	0.32	0.32	0.36
1.6335	762.26	764.23	765.96	762.58	764.56	766.31	0.32	0.33	0.35
1.643	762.46	764.55	766.38	762.78	764.90	766.74	0.32	0.35	0.36
2.016	763.64	765.59	767.39	763.97	765.94	767.75	0.33	0.35	0.36
2.097	763.98	765.95	767.74	764.31	766.29	768.10	0.33	0.34	0.36
2.111	764.31	766.45	768.40	764.67	766.83	768.76	0.36	0.38	0.36
2.165	765.08	767.27	769.24	765.46	767.66	769.61	0.38	0.39	0.37
2.179	765.46	767.79	769.89	765.87	768.21	770.29	0.41	0.42	0.40

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
2.491	766.05	768.33	770.38	766.45	768.74	770.78	0.40	0.41	0.40
2.525	766.10	768.38	770.43	766.50	768.79	770.82	0.40	0.41	0.39
2.536	766.64	769.16	771.38	767.12	769.60	771.81	0.48	0.44	0.43
3.05	768.54	771.03	773.21	769.02	771.47	773.64	0.48	0.44	0.43
3.405	769.43	771.92	774.09	769.91	772.36	774.52	0.48	0.44	0.43
3.427	769.75	772.31	774.54	770.25	772.77	774.99	0.50	0.46	0.45
3.96	770.71	773.23	775.41	771.20	773.68	775.85	0.49	0.45	0.44
4.276	771.23	773.72	775.89	771.71	774.17	776.33	0.48	0.45	0.44
4.284	771.42	773.97	776.21	771.92	774.44	776.67	0.50	0.47	0.46
4.48	771.78	774.32	776.54	772.27	774.78	777.00	0.49	0.46	0.46
4.949	773.18	775.73	777.92	773.68	776.17	778.36	0.5	0.44	0.44
4.97	773.41	776.00	778.24	773.91	776.45	778.68	0.5	0.45	0.44
5.506	773.93	776.51	778.73	774.41	776.94	779.15	0.48	0.43	0.42
5.52	773.97	776.55	778.77	774.45	776.99	779.2	0.48	0.44	0.43
5.811	774.47	777.06	779.28	774.94	777.49	779.7	0.47	0.43	0.42
5.831	774.49	777.10	779.33	774.97	777.53	779.75	0.48	0.43	0.42
6.88	774.97	777.55	779.77	775.43	777.97	780.17	0.46	0.42	0.4
7.329	775.21	777.78	779.98	775.66	778.18	780.38	0.45	0.4	0.4
7.333	775.22	777.79	780.00	775.67	778.19	780.38	0.45	0.4	0.38
7.342	775.24	777.81	780.01	775.7	778.22	780.41	0.46	0.41	0.4
7.351	775.27	777.82	780.03	775.71	778.23	780.42	0.44	0.41	0.39
7.36	775.29	777.85	780.06	775.74	778.25	780.45	0.45	0.4	0.39
7.364	775.31	777.86	780.07	775.75	778.26	780.46	0.44	0.4	0.39
7.65	775.65	778.20	780.38	776.08	778.58	780.76	0.43	0.38	0.38
8.42	776.75	779.26	781.42	777.14	779.62	781.77	0.39	0.36	0.35
9.04	777.31	779.79	781.91	777.69	780.13	782.25	0.38	0.34	0.34
9.49	778.00	780.43	782.51	778.35	780.76	782.83	0.35	0.33	0.32
9.505	778.02	780.51	782.63	778.39	780.84	782.96	0.37	0.33	0.33
9.82	778.59	781.07	783.21	778.94	781.42	783.56	0.35	0.35	0.35
10.4	778.80	781.27	783.39	779.14	781.61	783.73	0.34	0.34	0.34
10.6	779.00	781.46	783.57	779.34	781.8	783.91	0.34	0.34	0.34
10.9	779.85	782.25	784.30	780.16	782.56	784.62	0.31	0.31	0.32

	Future Conditions Without Project			Estimated Future Conditions With Project			Δ Water Surface		
River	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr	500-yr	750-yr	1000-yr
Mile	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev	W.S. Elev
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
11.35	780.29	782.67	784.70	780.6	782.97	785.01	0.31	0.3	0.31
11.85	780.85	783.19	785.19	781.14	783.48	785.49	0.29	0.29	0.3
12.4	781.22	783.52	785.45	781.5	783.8	785.73	0.28	0.28	0.28
12.94	781.44	783.70	785.68	781.71	783.98	785.96	0.27	0.28	0.28
13.3	781.68	784.02	785.97	781.95	784.28	786.24	0.27	0.26	0.27
13.65	781.96	784.26	786.18	782.22	784.52	786.45	0.26	0.26	0.27
14.25	782.15	784.43	786.35	782.4	784.69	786.61	0.25	0.26	0.26
14.62	782.30	784.58	786.48	782.55	784.83	786.74	0.25	0.25	0.26

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

Table 8. Upstream and Opposite Bank Induced Damages Due to Argentine n500+0 Raise

River Mile	Future Conditions Without Project 500-yr	750-yr	1000-yr	1250-yr	1500-yr	Estimated Future Conditions With Project 500-yr	750-yr	1000-yr	1250-yr	1500-yr	Δ Water Surface 500-yr	750-yr	1000-yr	1250-yr	1500-yr
4.949	773.18	775.73	777.92	779.38	780.68	773.18	775.73	777.92	779.38	780.68	0.00	0.00	0.00	0.00	0.00
4.97	773.41	776.00	778.24	779.74	781.07	773.41	776.00	778.25	779.75	781.08	0.00	0.00	0.01	0.01	0.01
5.506	773.93	776.51	778.73	780.22	781.54	773.93	776.51	778.73	780.22	781.54	0.00	0.00	0.00	0.00	0.00
5.52	773.97	776.55	778.77	780.27	781.59	773.97	776.55	778.77	780.27	781.59	0.00	0.00	0.00	0.00	0.00
5.811	774.47	777.06	779.28	780.78	782.11	774.49	777.09	779.32	780.85	782.19	0.02	0.03	0.04	0.07	0.08
5.831	774.49	777.10	779.33	780.84	782.18	774.53	777.14	779.41	780.95	782.29	0.04	0.04	0.08	0.11	0.11
6.88	774.97	777.55	779.77	781.26	782.59	775.01	777.62	779.86	781.37	782.73	0.04	0.07	0.09	0.11	0.14
7.329	775.21	777.78	779.98	781.46	782.80	775.25	777.84	780.09	781.58	782.94	0.04	0.06	0.11	0.12	0.14
7.333	775.22	777.79	780.00	781.47	782.81	775.28	777.87	780.10	781.60	782.96	0.06	0.08	0.10	0.13	0.15
7.342	775.24	777.81	780.01	781.50	782.83	775.26	777.82	780.04	781.53	782.86	0.02	0.01	0.03	0.03	0.03
7.351	775.27	777.82	780.03	781.51	782.84	775.27	777.84	780.04	781.52	782.86	0.00	0.02	0.01	0.01	0.02
7.36	775.29	777.85	780.06	781.54	782.87	775.29	777.85	780.06	781.54	782.87	0.00	0.00	0.00	0.00	0.00
7.364	775.31	777.86	780.07	781.55	782.88	775.31	777.86	780.07	781.55	782.88	0.00	0.00	0.00	0.00	0.00
7.65	775.65	778.20	780.38	781.85	783.17	775.65	778.20	780.38	781.85	783.17	0.00	0.00	0.00	0.00	0.00
8.42	776.75	779.26	781.42	782.87	784.18	776.83	779.39	781.61	783.10	784.47	0.08	0.13	0.19	0.23	0.29
9.04	777.31	779.79	781.91	783.34	784.63	777.39	779.94	782.15	783.63	784.98	0.08	0.15	0.24	0.29	0.35
9.49	778.00	780.43	782.51	783.92	785.19	778.14	780.65	782.84	784.33	785.66	0.14	0.22	0.33	0.41	0.47
9.505	778.02	780.51	782.63	784.07	785.36	778.16	780.71	782.95	784.44	785.80	0.14	0.20	0.32	0.37	0.44
9.82	778.59	781.07	783.21	784.67	786.00	778.75	781.31	783.57	785.10	786.49	0.16	0.24	0.36	0.43	0.49
10.4	778.80	781.27	783.39	784.84	786.17	778.96	781.53	783.77	785.29	786.71	0.16	0.26	0.38	0.45	0.54
10.6	779.00	781.46	783.57	785.02	786.34	779.16	781.70	783.94	785.47	786.86	0.16	0.24	0.37	0.45	0.52
10.9	779.85	782.25	784.30	785.71	787.01	779.99	782.48	784.64	786.13	787.51	0.14	0.23	0.34	0.42	0.50
11.35	780.29	782.67	784.70	786.10	787.38	780.43	782.89	785.05	786.52	787.88	0.14	0.22	0.35	0.42	0.50
11.85	780.85	783.19	785.19	786.57	787.84	780.99	783.40	785.51	786.97	788.31	0.14	0.21	0.32	0.40	0.47
12.4	781.22	783.52	785.45	786.81	788.07	781.36	783.73	785.77	787.20	788.53	0.14	0.21	0.32	0.39	0.46
12.94	781.44	783.70	785.68	787.03	788.28	781.58	783.91	785.99	787.40	788.72	0.14	0.21	0.31	0.37	0.44
13.3	781.68	784.02	785.97	787.31	788.54	781.80	784.21	786.27	787.69	788.98	0.12	0.19	0.30	0.38	0.44
13.65	781.96	784.26	786.18	787.51	788.73	782.06	784.46	786.47	787.87	789.17	0.10	0.20	0.29	0.36	0.44
14.25	782.15	784.43	786.35	787.66	788.88	782.27	784.61	786.65	788.01	789.30	0.12	0.18	0.30	0.35	0.42
14.62	782.30	784.58	786.48	787.79	789.00	782.42	784.78	786.77	788.14	789.41	0.12	0.20	0.29	0.35	0.41

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

Table 9. Upstream and Opposite Bank Induced Damages Due to Argentine n500+3 Raise

River Mile	Future Conditions Without Project					Estimated Future Conditions With Project					Δ Water Surface				
	500-yr	750-yr	1000-yr	1250-yr	1500-yr	500-yr	750-yr	1000-yr	1250-yr	1500-yr	500-yr	750-yr	1000-yr	1250-yr	1500-yr
4.949	773.18	775.73	777.92	779.38	780.68	773.18	775.73	777.92	779.38	780.68	0.00	0.00	0.00	0.00	0.00
4.97	773.41	776.00	778.24	779.74	781.07	773.41	776.00	778.26	779.75	781.08	0.00	0.00	0.02	0.01	0.01
5.506	773.93	776.51	778.73	780.22	781.54	773.93	776.51	778.73	780.22	781.54	0.00	0.00	0.00	0.00	0.00
5.52	773.97	776.55	778.77	780.27	781.59	773.97	776.55	778.77	780.27	781.59	0.00	0.00	0.00	0.00	0.00
5.811	774.47	777.06	779.28	780.78	782.11	774.49	777.10	779.34	780.86	782.21	0.02	0.04	0.06	0.08	0.10
5.831	774.49	777.10	779.33	780.84	782.18	774.53	777.16	779.43	780.97	782.32	0.04	0.06	0.10	0.13	0.14
6.88	774.97	777.55	779.77	781.26	782.59	775.01	777.65	779.89	781.41	782.76	0.04	0.10	0.12	0.15	0.17
7.329	775.21	777.78	779.98	781.46	782.80	775.25	777.86	780.11	781.61	782.98	0.04	0.08	0.13	0.15	0.18
7.333	775.22	777.79	780.00	781.47	782.81	775.28	777.89	780.13	781.63	783.00	0.06	0.10	0.13	0.16	0.19
7.342	775.24	777.81	780.01	781.50	782.83	775.26	777.81	780.02	781.52	782.86	0.02	0.00	0.01	0.02	0.03
7.351	775.27	777.82	780.03	781.51	782.84	775.27	777.82	780.03	781.51	782.87	0.00	0.00	0.00	0.00	0.03
7.36	775.29	777.85	780.06	781.54	782.87	775.29	777.85	780.06	781.54	782.87	0.00	0.00	0.00	0.00	0.00
7.364	775.31	777.86	780.07	781.55	782.88	775.31	777.86	780.07	781.55	782.88	0.00	0.00	0.00	0.00	0.00
7.65	775.65	778.20	780.38	781.85	783.17	775.65	778.20	780.38	781.85	783.17	0.00	0.00	0.00	0.00	0.00
8.42	776.75	779.26	781.42	782.87	784.18	776.83	779.44	781.69	783.18	784.56	0.08	0.18	0.27	0.31	0.38
9.04	777.31	779.79	781.91	783.34	784.63	777.39	780.03	782.25	783.75	785.10	0.08	0.24	0.34	0.41	0.47
9.49	778.00	780.43	782.51	783.92	785.19	778.14	780.80	782.99	784.48	785.82	0.14	0.37	0.48	0.56	0.63
9.505	778.02	780.51	782.63	784.07	785.36	778.16	780.86	783.10	784.59	785.95	0.14	0.35	0.47	0.52	0.59
9.82	778.59	781.07	783.21	784.67	786.00	778.75	781.46	783.73	785.27	786.66	0.16	0.39	0.52	0.60	0.66
10.4	778.80	781.27	783.39	784.84	786.17	778.96	781.69	783.94	785.47	786.89	0.16	0.42	0.55	0.63	0.72
10.6	779.00	781.46	783.57	785.02	786.34	779.16	781.87	784.11	785.65	787.05	0.16	0.41	0.54	0.63	0.71
10.9	779.85	782.25	784.30	785.71	787.01	779.99	782.63	784.80	786.29	787.68	0.14	0.38	0.50	0.58	0.67
11.35	780.29	782.67	784.70	786.10	787.38	780.43	783.03	785.20	786.68	788.04	0.14	0.36	0.50	0.58	0.66
11.85	780.85	783.19	785.19	786.57	787.84	780.99	783.53	785.66	787.12	788.47	0.14	0.34	0.47	0.55	0.63
12.4	781.22	783.52	785.45	786.81	788.07	781.36	783.86	785.92	787.35	788.68	0.14	0.34	0.47	0.54	0.61
12.94	781.44	783.70	785.68	787.03	788.28	781.58	784.04	786.13	787.55	788.88	0.14	0.34	0.45	0.52	0.60
13.3	781.68	784.02	785.97	787.31	788.54	781.80	784.34	786.40	787.83	789.13	0.12	0.32	0.43	0.52	0.59
13.65	781.96	784.26	786.18	787.51	788.73	782.06	784.58	786.60	788.01	789.32	0.10	0.32	0.42	0.50	0.59
14.25	782.15	784.43	786.35	787.66	788.88	782.27	784.73	786.79	788.15	789.45	0.12	0.30	0.44	0.49	0.57
14.62	782.30	784.58	786.48	787.79	789.00	782.42	784.90	786.90	788.28	789.56	0.12	0.32	0.42	0.49	0.56

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

Table 10. Upstream and Opposite Bank Induced Damages Due to Argentine n500+5 Raise

River	Future Conditions Without Project					Estimated Future Conditions With Project					Δ Water Surface				
Mile	500-yr	750-yr	1000-yr	1250-yr	1500-yr	500-yr	750-yr	1000-yr	1250-yr	1500-yr	500-yr	750-yr	1000-yr	1250-yr	1500-yr
4.949	773.18	775.73	777.92	779.38	780.68	773.18	775.73	777.92	779.38	780.68	0.00	0.00	0.00	0.00	0.00
4.97	773.41	776.00	778.24	779.74	781.07	773.41	776.00	778.26	779.75	781.09	0.00	0.00	0.02	0.01	0.02
5.506	773.93	776.51	778.73	780.22	781.54	773.93	776.51	778.73	780.22	781.54	0.00	0.00	0.00	0.00	0.00
5.52	773.97	776.55	778.77	780.27	781.59	773.97	776.55	778.77	780.27	781.59	0.00	0.00	0.00	0.00	0.00
5.811	774.47	777.06	779.28	780.78	782.11	774.49	777.10	779.34	780.87	782.22	0.02	0.04	0.06	0.09	0.11
5.831	774.49	777.10	779.33	780.84	782.18	774.53	777.16	779.45	780.99	782.34	0.04	0.06	0.12	0.15	0.16
6.88	774.97	777.55	779.77	781.26	782.59	775.01	777.65	779.91	781.42	782.79	0.04	0.10	0.14	0.16	0.20
7.329	775.21	777.78	779.98	781.46	782.80	775.25	777.86	780.12	781.63	783.00	0.04	0.08	0.14	0.17	0.20
7.333	775.22	777.79	780.00	781.47	782.81	775.28	777.89	780.14	781.64	783.01	0.06	0.10	0.14	0.17	0.20
7.342	775.24	777.81	780.01	781.50	782.83	775.26	777.81	780.01	781.51	782.85	0.02	0.00	0.00	0.01	0.02
7.351	775.27	777.82	780.03	781.51	782.84	775.27	777.82	780.03	781.51	782.86	0.00	0.00	0.00	0.00	0.02
7.36	775.29	777.85	780.06	781.54	782.87	775.29	777.85	780.06	781.54	782.87	0.00	0.00	0.00	0.00	0.00
7.364	775.31	777.86	780.07	781.55	782.88	775.31	777.86	780.07	781.55	782.88	0.00	0.00	0.00	0.00	0.00
7.65	775.65	778.20	780.38	781.85	783.17	775.65	778.20	780.38	781.85	783.17	0.00	0.00	0.00	0.00	0.00
8.42	776.75	779.26	781.42	782.87	784.18	776.83	779.44	781.72	783.23	784.61	0.08	0.18	0.30	0.36	0.43
9.04	777.31	779.79	781.91	783.34	784.63	777.39	780.03	782.31	783.80	785.16	0.08	0.24	0.40	0.46	0.53
9.49	778.00	780.43	782.51	783.92	785.19	778.14	780.80	783.09	784.57	785.91	0.14	0.37	0.58	0.65	0.72
9.505	778.02	780.51	782.63	784.07	785.36	778.16	780.86	783.19	784.67	786.03	0.14	0.35	0.56	0.60	0.67
9.82	778.59	781.07	783.21	784.67	786.00	778.75	781.46	783.83	785.36	786.76	0.16	0.39	0.62	0.69	0.76
10.4	778.80	781.27	783.39	784.84	786.17	778.96	781.69	784.05	785.57	787.00	0.16	0.42	0.66	0.73	0.83
10.6	779.00	781.46	783.57	785.02	786.34	779.16	781.86	784.22	785.75	787.15	0.16	0.40	0.65	0.73	0.81
10.9	779.85	782.25	784.30	785.71	787.01	779.99	782.63	784.90	786.38	787.78	0.14	0.38	0.60	0.67	0.77
11.35	780.29	782.67	784.70	786.10	787.38	780.43	783.03	785.30	786.77	788.14	0.14	0.36	0.60	0.67	0.76
11.85	780.85	783.19	785.19	786.57	787.84	780.99	783.53	785.76	787.21	788.56	0.14	0.34	0.57	0.64	0.72
12.4	781.22	783.52	785.45	786.81	788.07	781.36	783.86	786.01	787.43	788.78	0.14	0.34	0.56	0.62	0.71
12.94	781.44	783.70	785.68	787.03	788.28	781.58	784.04	786.22	787.63	788.97	0.14	0.34	0.54	0.60	0.69
13.3	781.68	784.02	785.97	787.31	788.54	781.80	784.34	786.49	787.91	789.21	0.12	0.32	0.52	0.60	0.67
13.65	781.96	784.26	786.18	787.51	788.73	782.06	784.58	786.68	788.09	789.40	0.10	0.32	0.50	0.58	0.67
14.25	782.15	784.43	786.35	787.66	788.88	782.27	784.73	786.87	788.23	789.53	0.12	0.30	0.52	0.57	0.65
14.62	782.30	784.58	786.48	787.79	789.00	782.42	784.90	786.98	788.36	789.64	0.12	0.32	0.50	0.57	0.64

Shaded Cells are Induced Water Surface Increases that Controlled for HEC-FDA Analysis

KANSAS CITYS
EXHIBIT #14: WITH PROJECT ENGINEERING PERFORMANCE

	OVERALL RELIABILITY AGAINST 1% EVENT				EXPECTED PROBABILITY OF EXCEEDANCE (FLOODING) IN ANY GIVEN YEAR			EQUIVALENT LONG TERM RISK (Probability of Exceedance (Flooding)Over the Indicated Time Period)								
								WITHOUT PROJECT			WITH PROJECT			*Incremental Decrease in Annual Risk Over the Indicated Atime Period*		
Alternatives and Overall Selected Plan	**Existing Condition Reliability**	**Future Without-Project Condition Reliability**	**Future With-Project Condition Reliability**	***Incremental Increase in Reliability from the Fut WO Cond***	**WITHOUT PROJECT**	**WITH PROJECT**	***Incremental Decrease in Annual Probability of Exceedance***	**10 Years**	**25 Years**	**50 Years**	**10 Years**	**25 Years**	**50 Years**	**10 Years**	**25 Years**	**50 Years**
ARGENTINE UNIT	0.49	0.49			0.013			0.125	0.284	0.487						
Arg 1, nominal 500+0 raise			0.95	*0.47*		0.003	*-0.010*				0.0302	0.074	0.142	*-0.095*	*-0.210*	*-0.345*
Arg 2, nominal 500+3 raise (NED Plan)			0.99	*0.50*		0.002	*-0.011*				0.0194	0.048	0.093	*-0.106*	*-0.236*	*-0.394*
Arg 3, nominal 500+5 raise			0.99	*0.51*		0.001	*-0.012*				0.0132	0.033	0.064	*-0.112*	*-0.251*	*-0.423*
Arg 4, No Raise, Pump Sta Improvements & Earthwork			0.90	*0.42*		0.004	*-0.009*				0.0424	0.103	0.195	*-0.083*	*-0.181*	*-0.292*
FAIRFAX-JERSEY CR UNIT (2 sites)	0.82	0.82			0.007			0.064	0.152	0.281						
BPU Floodwall Solution Only; Residual Risk at JC Sheetpile Wall & Wharf Area Site																
Alt 1, Modified Wall (Add'l Row of Piles & Buttresses)			0.823	*0.006*		0.006	*-0.001*				0.061	0.147	0.272	*-0.003*	*-0.006*	*-0.010*
Alt 2, Combo Wall			0.823	*0.006*		0.006	*-0.001*				0.061	0.147	0.272	*-0.003*	*-0.006*	*-0.010*
JC Sheetpile Wall & Wharf Area Solution Only; Residual Risk at BPU Floodwall Site																
Alt 1 Flood Fight											0.018	0.044	0.086	*-0.046*	*-0.108*	*-0.195*
Alt 2, New Closed Cell Sheetpile Wall			0.98	*0.16*		0.002	*-0.005*				0.018	0.044	0.086	*-0.046*	*-0.108*	*-0.195*
Alt 3, New Wall, Auger Cast Piles & Tiebacks			0.98	*0.16*		0.002	*-0.005*				0.018	0.044	0.086	*-0.046*	*-0.108*	*-0.195*
Alt 4, New Open Cell Sheetpile Wall			0.98	*0.16*		0.002	*-0.005*				0.018	0.044	0.086	*-0.046*	*-0.108*	*-0.195*
Total Plan Fairfax-JC Unit: BPU Floodwall Solution and JC Sheetpile Wall & Wharf Area Solution			**0.99**	***0.17***		**0.001**	***-0.006***				**0.013**	**0.032**	**0.062**	***-0.051***	***-0.121***	***-0.219***
NORTH KANSAS CITY UNIT (2 sites)	0.85	0.85			0.005			0.053	0.128	0.240						
Harlem Solution Only; Residual Risk at National Starch Site																
Alt 1, Flood Fight			-													
Alt 2, Landside Seepage Berm			0.93	*0.08*		0.003	*-0.002*				0.034	0.082	0.158	*-0.020*	*-0.046*	*-0.082*
Alt 3, Buried Collector System			0.93	*0.08*		0.003	*-0.002*				0.034	0.082	0.158	*-0.020*	*-0.046*	*-0.082*
Alt 4, Pressure Relief Wells			0.93	*0.08*		0.003	*-0.002*				0.034	0.082	0.158	*-0.020*	*-0.046*	*-0.082*
National Starch Solution Only; Residual Risk at Harlem Site																
Alt 1, Relief Well System			0.88	*0.04*		0.005	*Less than -0.001*				0.045	0.109	0.206	*-0.008*	*-0.019*	*-0.033*
Total Plan North Kansas City Unit: Harlem Solution and National Starch Solution			**0.98**	***0.13***		**0.001**	***-0.004***				**0.011**	**0.027**	**0.054**	***-0.042***	***-0.101***	***-0.186***
EAST BOTTOMS UNIT (confluence site)	0.96	0.96			0.002			0.024	0.059	0.115						
Alt 1, Flood Fight																
Alt 2 Sheetpile Wall			0.998	*0.043*		0.0003	*-0.0017*				0.003	0.008	0.017	*-0.021*	*-0.051*	*-0.099*
Alt 3 Slurry Cut-Off Wall			0.998	*0.043*		0.0003	*-0.0017*				0.003	0.008	0.017	*-0.021*	*-0.051*	*-0.099*
Alt 4, Pressure Relief Wells			0.998	*0.043*		0.0003	*-0.0017*				0.003	0.008	0.017	*-0.021*	*-0.051*	*-0.099*
KANSAS CITYS OVERALL PLAN, PHASE 1 UNITS	.49 to .96	.49 to .96			.002 to .013											
Argentine Alt 2 (Nom 500+3 Raise)			0.99	*0.50*		0.002	*-0.011*				0.019	0.048	0.093	*-0.106*	*-0.236*	*-0.394*
Fairfax BPU Alt 1 Modified Wall and JC Sheetpile Wall Alt 2, New Closed Cell Sheetpile Wall			0.99	*0.17*		0.001	*-0.006*				0.013	0.032	0.062	*-0.051*	*-0.121*	*-0.219*
North Kansas City Harlem Alt 3 Buried Collector System and National Starch alt 1 Relief Well System			0.98	*0.13*		0.001	*-0.004*				0.011	0.027	0.054	*-0.042*	*-0.101*	*-0.186*
East Bottoms Alt 4 Pressure Relief Wells			0.998	*0.043*		0.0003	*-0.002*				0.003	0.008	0.017	*-0.021*	*-0.051*	*-0.099*
TOTAL OVERALL PLAN, PHASE 1 UNITS			.98 to .998			0.0003 to 0.002					.003 to .019	.008 to .048	.017 to .093			

Note: any discrepancies due to rounding

EXHIBIT #15: Annual Damages, Benefits and Costs With and Without Project

October 2005 Prices, 5.125% Interest Rate, 50 Year Period of Analysis, $000

	Argentine Unit Nom 500+3 Raise	**Fairfax-Jersey Cr Unit Total Plan**	**North Kansas City Unit Total Plan**	**East Bottoms Unit Plan**	**Overall NED Plan**
WITHOUT PROJECT ANNUAL DAMAGES					
Physical Flood Damages	$19,221.0	$14,553.0	$10,021.0	$6,504.0	$50,299.0
Other Costs of Flooding	$3,105.0	$2,010.0	$1,760.0	$840.0	$7,715.0
Total WITHOUT Project Equivalent Annual Damages	$22,326.0	$16,563.0	$11,781.0	$7,344.0	$58,014.0
WITH PROJECT ANNUAL RESIDUAL DAMAGES					
Physical Flood Damages	$3,523.0	$3,943.0	$4,184.0	$2,594.0	$14,244.0
Other Costs of Flooding	$637.0	$606.0	$731.0	$392.0	$2,366.0
Total WITH Project Residual Annual Damages	$4,160.0	$4,549.0	$4,915.0	$2,986.0	$16,610.0
WITH PROJECT ANNUAL BENEFITS					
Flood Damage Reduction Benefits	$15,698.0	$10,609.0	$5,838.0	$3,911.0	$36,055.0
Reduction in Other Costs of Flooding	$2,468.0	$1,405.0	$1,028.0	$447.0	$5,348.0
Total Annual NED Benefits of Plan	$18,165.0	$12,014.0	$6,866.0	$4,358.0	$41,404.0
Other Beneficial Effects	Preservation of 185 acres of riparian habitat	--	--	--	Preservation of 185 acres of riparian habitat
WITH PROJECT ANNUAL COSTS					
Annualized Investment Cost	$3,243.0	$766.0	$480.0	$96.0	$4,585.0
Annual OMRR&R Cost (Increm.Incr.)	$13.0	$6.0	$35.0	$25.0	$79.0
Induced Damages	$207.0	$0	$0	$0	$207.0
Other Associated Costs (Annual)	$106.0	$199.0	$0	$0	$305.0
Total Annual NED Cost	$3,569.0	$970.0	$516.0	$121.0	$5,176.0
NED Benefit Cost Ratio	5.1	12.4	13.3	35.9	8.0
Net NED Benefits	$14,596.0	$11,044.0	$6,350.0	$4,237.0	$36,228.0

Note: Any discrepancies are due to rounding

EXHIBIT #16: Recommended Plan -- Annual Performance and Equivalent Long-term Risk

Plan	Top of Levee/ Floodwall Elevation (ft)	Annual Exceedance Probability (Expected Probability that Flooding Will Occur in any Given Year)	Equivalent Long-term Risk (Probability of Exceedance (Flooding) Over the Indicated Time Period)		
			10 Years	25 Years	50 Years
ARGENTINE UNIT					
Future Without Project	776.00	.013	.125	.284	.487
Alt 2 Nom 500+3	781.24	.002	.019	.048	.093
FAIRFAX-JERSEY CREEK UNIT					
Future Without Project	760.50	.007	.064	.152	.281
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.50	.001	.013	.032	.062
NORTH KANSAS CITY UNIT					
Future Without Project	755.50	.005	.053	.128	.240
Total North Kansas City Unit Plan (Harlem and National Starch sites Solutions)	755.50	.001	.011	.027	.054
EAST BOTTOMS UNIT					
Future Without Project	746.30	.002	.024	.059	.115
East Bottoms Unit Plan (Blue R. Confluence Site Solution)	746.30	.0003	.003	.008	.017
OVERALL PLAN		.0003 to .002	.003 to.019	.008 to .048	.017 to .093

EXHIBIT #17
PERSPECTIVES and DISCUSSION ON
KANSAS CITYS LEVEES PERFORMANCE ANALYSIS

Principles of Flood Damage Reduction Planning and Associated Analysis

The Corps of Engineers functions and operates in accordance with laws established by Congress. The Corps develops policy and guidance for implementation of the laws under which it operates. The laws, and Corps policy and guidance, provide for the use of prescribed methodologies and nationwide uniformity in the Corps planning process. Corps planning products are reviewed locally, independently, and by three levels of Washington review, i.e., Corps Headquarters, Assistant Secretary of the Army for Civil Works, and Office of Management and Budget. Reviews not only ensure consistency and accuracy in the application of the prescribed methodologies, but determine and confirm that the work was completed with adherence to guidance, policy and the law.

The structured and uniform planning process implemented and followed by the Corps of Engineers is documented in Engineering Regulation 1105-2-100, Planning Guidance Notebook. This regulation is grounded in the laws which apply to the Civil Works Program and to the Corps of Engineers missions, and is particularly based on the <u>Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies</u> (P&G) (March 10, 1983). The P&G were established pursuant to Section 103 of the Water Resources Planning Act (Public Law 89-80) and Executive Order 11747.

Corps policy and guidance provide for proper and consistent planning in the formulation of reasonable plans responsive to National, State, and local concerns. The resulting plans recommended for implementation are economically and environmentally sound and in general reasonably maximize net national economic development benefits, consistent with protecting the Nation's environment (NED plan). Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, and are the direct net benefits that accrue in the planning area and in the rest of the nation as a result of project implementation.

The Corps uniform planning process includes certain fundamental principles in the analysis of flood damage reduction alternatives. These principles include, among others:

- <u>With and Without-Project Analysis</u>. The without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project. The future without project condition constitutes the benchmark against which plans are evaluated.

- <u>Benefit-Cost Analysis and Cost Effectiveness Analysis</u>. This is a framework used in evaluating government investments. All pertinent costs and effects of a proposed project are systematically identified and tallied. The stream of monetized benefits that occur through time with project implementation are accumulated and are discounted to a base year in order to express a single total benefit figure. Similarly on the cost side the same accumulating and discounting process is conducted so the costs are also expressed as a single value in the base year. This process allows direct comparison of benefits and costs on a common basis. If the benefits exceed the costs the project is considered economically justified. Allowable benefits categories and required cost categories to be used in analysis of Corps water resource projects are standardized across the nation. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining that objective.

- Net Benefits, Optimization Analysis. Benefits can be monetary or non-monetary. The scale of flood damage reduction alternative that reasonably maximizes expected net benefits (returns the greatest excess of benefits over costs) is the National Economic Development (NED) Plan.

- Risk and Uncertainty. Risk-based analysis is defined as an approach to evaluation and decision making that explicitly, and to the extent practical, analytically, incorporates considerations of risk and uncertainty in a flood damage reduction study. In water resources planning, risk-based analysis is used to compare plans in terms of the likelihood and variability of their physical performance, economic success and residual risks. It captures and quantifies the extent of risk and uncertainty in the various planning and design components of an investment project.

Risk Based Analysis of Flood Damage Reduction Alternatives

Flood damage reduction projects can significantly reduce risk of flooding, but 100% absolute protection from flooding is not an achievable goal. A zero residual risk does not exist because no project can completely eliminate natural hazards. Flooding may occur less frequently but there is always some residual risk of flooding after implementation of any flood damage reduction project.

Historically, many flood control projects were planned, designed, and constructed on the Standard Project Flood (SPF). The SPF was generated using modeling techniques to determine a single target design discharge. In later years, the SPF may have been associated with a return interval to describe an expected level of protection for a given flood control project. In the context of risk analysis guidance, the SPF is no longer used for a “target design”. Instead, a range of floods, including those that exceed the SPF, are to be used in formulation and evaluation of alternatives. The historic SPF method relied on safety factors and freeboard, estimates of worst case scenarios, and other indirect methods to compensate for uncertainty. These indirect methods were necessitated due to the mathematical complexities involved in computing the interaction of uncertainties in hydrologic, hydraulic, and economic functions. However, with computational advances it is now possible to describe these uncertainties explicitly and calculate that interaction.

For risk and uncertainty analysis, the Corps of Engineers uses risk-based analysis procedures for formulating and evaluating flood damage reduction measures according to guidance in Engineering Manual 1110-2-1619, Engineering and Design Risk Based Analysis for Flood Damage Reduction Studies; and in Engineering Regulation 1105-2-101, Planning Risk Analysis for Flood Damage Reduction Studies. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. Flooding is random in nature and flood problems are multi-dimensional making it difficult to fully understand, document, and model the physical nature of flooding, its magnitude, its probability of occurrence, and its consequences. Risk is defined as the probability an area will be flooded, resulting in undesirable consequences. Uncertainty is a measure of imprecision of knowledge of parameters and functions used to describe the hydraulic, hydrologic, geotechnical, structural, and economic aspects of a project plan.

In water resource planning for flood damage reduction, uncertainties in the hydrologic and hydraulic data about discharges and flood stages, uncertainties in economic data about investment values, beginning damage elevations, and damages with various flood depths, and uncertainties about the potential for geotechnical or structural failure of features in an existing flood control project can have significant impact on the residual damages, benefits, costs, planning, design, and reliabilities of a proposed flood control project.

To develop a risk based analysis as required by regulation, the Corps uses the HEC (Hydrologic Engineering Center) Flood Damage reduction Analysis (HECFDA) model. The HECFDA model combines the engineering and economic study data to determine economic performance (flood damages) and engineering performance (probability of design exceedance) with and without a flood control project. The HECFDA model uses the Monte Carlo simulation process which incorporates the risk and uncertainties associated with the required HECFDA input values.

Planners cannot know with full certainty the exact value of a variable that may ultimately be important to the selection and implementation of a plan. The analysis instead considers a best estimate of the value, and recognizes the uncertainty inherent in that value by also using other possible values (often in terms of input curve). The range of outcomes in some areas of risk and uncertainty can be reasonably described or characterized by a probability distribution. Certain future demographic, economic, hydrologic, and meteorological events are essentially unpredictable because they are subject to random influences; however the randomness can sometimes be described by a probability distribution based on historical data. If there is no historical database, the probability distribution of random future events can be described subjectively, based on insight and judgment.

Key variables explicitly incorporated into the risk based analyses used in the Kansas Citys feasibility study included the following:

- <u>Hydraulic uncertainty</u>. A stage-exceedance probability function was developed from the water surface profiles and a normal probability distribution was selected. Conveyance roughness and cross-section geometry were evaluated to determine a standard deviation of 1.5 feet in the base year and 1.8 feet in future years for uncertainty in river elevation, given a certain discharge.

- <u>Hydrologic uncertainty</u>. A graphical discharge-frequency exceedance probability function was developed in the HEC-FDA model for each reach based on a 70 year period of record. The distribution of errors is assumed to be a non-central t-distribution about the specified function.

- <u>Investment value uncertainty</u>. Interview data about most likely structure and content values, and the minimum and maximum range of values for each were obtained from business owners and representatives and entered into HEC-FDA. For structures that did not have specific data obtained by surveys and interviews, expected values for structures and contents were estimated using Marshall & Swift professional valuation software or from locally obtained study area data for similar businesses. The uncertainty was defined using a normal or triangular probability distribution, depending on the type of structure and category of damage, and any other specific data available.

- Structure and beginning damage elevation uncertainty. Uncertainties about ground and first floor elevations (beginning damage elevations) were determined based on two and four foot contours on study area mapping. Uncertainties were determined per guidance in Engineering Manual 1110-2-1619, Risk Based Analysis for Flood Damage Reduction Studies.

- Depth-damage relationship uncertainty. Structure occupancy types were defined for each type of structure and category of damage. The structure occupancy code defines the depth-percent damage function and its uncertainties. Normal and triangular probability distributions were used based on the category of damage, type of structure, and type of use.

- Uncertainty about geotechnical or structural failure. Probabilities of geotechnical and structural failure in each unit were developed using engineering analysis. Geotechnical and structural engineers determined the most likely expected modes and sites of failure prior to overtopping in each unit. A range of conditional probabilities of failure versus river stage elevation encompassing the probable failure point and non failure point were determined for each site/mode of failure. The river elevation versus probability of failure relationship developed by the geotechnical and structural engineers for each potential failure site/mode was then translated to the index point of the reach (levee unit) and each individual potential failure site/mode was determined to be independent. The probabilities of failure for each site/mode were then combined using a formula contained in ETL 1110-2-556 to derive a single combined probability of failure versus river stage curve that accounted for all the sites or modes of potential failure. The resulting combined probability of failure curve was then entered into the HECFDA study file.

Future With-and Without-Project Condition Economic Performance

Economic Performance of Overall Plan. Implementation of the recommended plan (NED plan) in each of the units addressed in the interim feasibility report will provide significant reduction in physical flood damages and other costs that result from flooding. The damages reduced represent the benefits provided by the recommended plan and are typically characterized in terms of annualized equivalent values as computed in the HECFDA program.

The table on the following page summarizes the equivalent annual damages that would be expected to occur with and without the recommended plan. The uncertainties in evaluation of project benefits are characterized in the far right three columns of the table. For example, for the Argentine Unit recommended plan would provide expected benefits (flood damages and other costs of flooding reduced by the plan) in excess of $18 million annually. Based on risk and uncertainty analyses, there is a 75% probability that these benefits are nearly $8 million annually, a 50% probability that benefits provided would be more than $14 million annually, and a 25% probability that project benefits would be more than $24.6 million annually.

Equivalent Annual Damages and Damages Reduced (Oct 2005 Prices, 5.125% Inter Rate, 50 Yr Period of Anal, $000

Plan	Top of Levee/ Floodwall Elev (ft)	Expected Value and Probabilistic Values of EAD and EAD Reduced					
		Equivalent Annual Damage			Probability EAD Reduced Exceeds Indicated Amount		
		Without Plan	With Plan	Damage Reduced	.75	.50	.25
ARGENTINE UNIT							
Future **WITHOUT** Project	776.00	$22,326.0	-	-	-	-	-
Future **WITH** Project: Alt 2 Nom 500+3 (NED Plan)	781.24		$4,160.0	$18,165.0	$7,852.0	$14,661.0	$24,640.0
FAIRFAX-JERSEY CREEK UNIT							
Future **WITHOUT** Project	760.5	$16,563.0	-	-	-	-	-
Future **WITH** Project: Total Fairfax-Jersey Cr Unit NED Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.5		$4,549.0	$12,014.0	$4,241.0	$8,635.0	$16,529.0
NORTH KANSAS CITY UNIT							
Future **WITHOUT** Project	755.5	$11,781.0	-	-	-	-	-
Future **WITH** Project: Total North Kansas City Unit NED Plan (Harlem and National Starch Sites Solutions)	755.5		$4,915.0	$6,866.0	$2,859.0	$5,155.0	$8,777.0
EAST BOTTOMS UNIT							
Future **WITHOUT** Project	746.3	$7,344.0	-	-	-	-	-
Future **WITH** Project: East Bottoms Unit NED Plan (Confluence Site Solution)	746.3		$2,986.0	$4,358.0	$2,014.0	$2,968.0	$5,139.0

Future With- and Without-Project Condition Engineering Performance

Conditional Probability of Design Non-Exceedance. One of the many metrics that can be used to characterize the performance of a flood protection project is overall project reliability against the 1% event. Project reliability is characterized in the HECFDA model by the probability of the project design containing a specified event or the probability of design non-exceedance. Overall reliability against the 1% event and other engineering performance data include consideration of both the probability of overtopping and also the probability of geotechnical and structural failure.

The table below displays for each unit addressed in the Interim Feasibility Report the with- and without- project condition overall project reliability against the 1% probability event, and shows the top of levee margins above the 1% and 0.2% event water surface profile.

FUTURE CONDITION OVERTOPPING MARGINS AND OVERALL RELIABILITY AGAINST THE 1% CHANCE EVENT WITH AND WITHOUT PROJECT				
	Top of Levee/ Floodwall Elev. at Index Point (ft, msl)	**Overtopping Margin (ft) Above 1.0% Chance Event Profile**	**Overtopping Margin (ft) Above the 0.2% Chance Event Profile**	**Overall Reliability Against the 1% Chance Event (includes geotechnical and structural risk considerations)**
ARGENTINE, Kansas R.M. 9.6				
Future **WITHOUT** Project	776.0	6.39	-2.24	0.49
Future **WITH** Project	781.24	11.63	3.0	0.99
Net Change in Margins and Overall Reliability	+5.24	+5.24	+5.24	+0.50
Argentine Recommended Plan: Nominal 500+3 Raise, including embankment, floodwall and pump station improvements. Argentine With Project Residual Risk: Overtopping potential; very minor geotechnical/structural residual risk near top of levee.				
FAIRFAX-JERSEY CREEK, Missouri R.M. 367.7				
Future **WITHOUT** Project	760.5*	8.97*	2.89*	0.82*
Future **WITH** Project	760.5*	8.97*	2.89*	0.99*
Net Change in Margins and Overall Reliability	No chg	No chg	No chg	+0.17
Fairfax-Jersey Creek Recommended Plan: BPU Floodwall Solution and Jersey Cr Sheetpile Wall solution. Fairfax-Jersey Creek With Project Residual Risk: Two flood fight locations, one near the Lower Tieback and one near the Jersey Cr Outlet; overtopping potential; very minor geotechnical/structural residual risk near top of levee. Low Point Initial Overtopping Location: Mouth of Kansas River Margin (ft) above 0.2% Water Surface at Low Point Location: 2.89				
NORTH KANSAS CITY, Missouri R.M. 365.8				
Future **WITHOUT** Project	755.5	6.69	1.05	0.85
Future **WITH** Project	755.5	6.69	1.05	0.98
Net Change in Margins and Overall Reliability	No chg	No chg	No chg	+0.13
North Kansas City Recommended Plan: Harlem Site Underseepage solution and National Starch Site Underseepage Solution. North Kansas City With Project Residual Risk: overtopping potential; very minor residual geotechnical risk near top of levee. Low Point Initial Overtopping Location: R.M. 369.1, North End of Downtown Airport Runway Margin (ft) above 0.2% Water Surface at Low Point Location: 1.05				
EAST BOTTOMS, Missouri R.M. 357.6				
Future **WITHOUT** Project	746.3	8.04	3.67	0.96
Future **WITH** Project	746.3	8.04	3.67	0.998
Net Change in Margins and Overall Reliability	No chg	No chg	No chg	+0.04 (additional reliability gains against lower probability events)
East Bottoms Recommended Plan: Underseepage Solution near the confluence of the Blue River. East Bottoms With Project Residual Risk: Minor structural risk at Floodwall Sta 64+48 to 74+56; very minor residual geotechnical risk near top of levee; overtopping potential. Low Point Initial Overtopping Location: R.M. 365.8 Margin (ft above 0.2% Water Surface at Low Point Location: 3.67				
BIRMINGHAM, Missouri R.M. 355.9				
Future **WITHOUT** Project	743.0	6.28	1.82	0.98
Future **WITH** Project	743.0	6.28	1.82	0.98
Net Change in Margins and Overall Reliability	No chg	No chg	No chg	No chg
Low Point Initial Overtopping Location: Shoal Creek Tieback Margin (ft) above 0.2% Water Surface at Low Point Location: 1.82				

*Overtopping margins and reliability data shown for Fairfax-Jersey Cr Unit assume a successful flood fight at lower tieback and Jersey Cr outlet
**Any discrepancies due to rounding

Levee Performance in Any Given Year and Equivalent Long-term Risk. Long-term risk indicates how successfully a flood control project would protect against floods given the uncertainties and over a long period of time. Annual Exceedance Probability is the probability that flooding will occur in any given year considering the full range of possible annual floods. (*Note:* The terms "exceeded" or "exceedance" when used herein with regard to engineering performance data include consideration of both geotechnical and structural failure potential and consideration of the potential for levee overtopping.)

For each of the units addressed by the Interim Feasibility Report, the table below shows the long-term risk or probability of the project being exceeded in a 10-, 25-, and 50-year period, with and without the recommended plan for each unit. The table below also shows the expected probability of the levee design being exceeded (occurrence of flooding) in any given year. For example, the Argentine Unit existing levee has a 0.013 probability of flooding in any year, given the range of possible flood events. With implementation of the recommended plan, the probability that the Argentine Unit will be flooded in any given year decreases to a 0.002 probability. Over a 50-year period, there is a 0.487 probability that the Argentine existing levee will be overtopped and/or suffer geotechnical/structural failure compared with a .093 probability with implementation of the recommended plan. The recommended plan provides a 0.394 decrease in probability of exceedance over a 50-year period. Significant decreases in probability of exceedance over 25 years and 10 years are also realized with implementation of the recommended plan.

ENGINEERING PERFORMANCE IN ANY GIVEN YEAR AND EQUIVALENT LONG-TERM RISK WITHOUT- PROJECT AND WITH-PROJECT RECOMMENDED PLAN					
	Top of Levee/ Floodwall Elevation (ft msl) at Index Pt.	**Annual Exceedance Probability (Expected Probability that Flooding Will Occur in any Given Year)**	**Equivalent Long-Term Risk (Probability of Exceedance Over the Indicated Time Period) (includes geotechnical and structural risk considerations)**		
			10 Years	25 Years	50 Years
ARGENTINE, Kansas R.M. 9.6					
Future **WITHOUT** Project	776.0	.013	.125	.284	.487
Future **WITH** Project	781.24	.002	.019	.048	.093
Net Change in Probability of Exceedance (Flooding)	+5.24 ft	-.011	-.106	-.236	-.394
FAIRFAX-JERSEY CREEK, Missouri R.M. 367.7					
Future **WITHOUT** Project	760.5	.007	.064	.152	.281
Future **WITH** Project	760.5	.001	.013	.032	.062
Net Change in Probability of Exceedance (Flooding)	No chg	-.006	-.051	-.120	-.219
NORTH KANSAS CTIY, Missouri R.M. 365.8					
Future **WITHOUT** Project	755.5	.005	.053	.128	.240
Future **WITH** Project	755.5	.001	.011	.027	.054
Net Change in Probability of Exceedance (Flooding)	No chg	-.004	-.042	-.101	-.186
EAST BOTTOMS, Missouri R.M. 357.6					
Future **WITHOUT** Project	746.3	.002	.024	.059	.115
Future **WITH** Project	746.3	.000	.003	.008	.017
Net Change in Probability of Exceedance (Flooding)	No chg	-.002	-.021	-.051	-.098
BIRMINGHAM, Missouri R.M. 355.9					
Future **WITHOUT** Project	743.0	.002	.015	.037	.072
Future **WITH** Project	No chg	No chg	No chg	No chg	No chg
Net Change in Probability of Exceedance (Flooding)	No chg	No chg	No chg	No chg	No chg

Note: Any discrepancies due to rounding

As shown in the table on the following page, long term risk can be alternatively described in terms of chance of flooding in any one year or in a specified time period. For example, the equivalent long-term residual risk with the recommended Argentine Unit plan in place can be characterized as follows: There is a 1 in 76.9 chance that the Argentine Unit will flood in any year under the future without project condition. With the recommended plan, the Argentine Unit has a 1 in 500 chance of flooding in any year. Over a fifty year period there is a 1 in 10.8 chance that the capacity of the project to protect against flooding will be exceeded one or more times.

This demonstrates a significant improvement over the without project condition risk of 1 in 2.1 chance over 50 years. Over 25 years, there is a 1 in 20.8 chance of the project design capacity being exceeded, again a significant improvement over the 1 in 3.5 chance with the existing project. Over 10 years there is a 1 in 52.6 chance with the recommended plan compared with a 1 in 8.0 chance with the existing project.

ALTERNATIVE DISPLAY OF ENGINEERING PERFORMANCE IN ANY GIVEN YEAR AND EQUIVALENT LONG TERM RISK WITHOUT PROJECT AND WITH-PROJECT RECOMMENDED PLAN					
	Top of Levee/ Floodwall Elevation at Index Point (ft msl)	**Chance of Exceedance (Flooding) in any Given Year**	**Equivalent Long-Term Risk (Chance of Exceedance Over the Indicated Time Period) (includes geotechnical and structural risk considerations)**		
			10 Years	25 Years	50 Years
ARGENTINE, Kansas R.M. 9.6					
Future **WITHOUT** Project	776.00	1 in 76.9	1 in 8.0	1 in 3.5	1 in 2.1
Future **WITH** Project	781.24	1 in 500	1 in 52.6	1 in 20.8	1 in 10.8
FAIRFAX-JERSEY CREEK, Missouri R.M. 367.7					
Future **WITHOUT** Project	760.50	1 in 142.9	1 in 15.6	1 in 6.6	1 in 3.6
Future **WITH** Project	760.50	1 in 1000	1 in 76.9	1 in 31.2	1 in 16.1
NORTH KANSAS CITY, Missouri R.M. 365.8					
Future **WITHOUT** Project	755.50	1 in 200	1 in 18.9	1 in 7.8	1 in 4.2
Future **WITH** Project	755.50	1 in 1000	1 in 90.9	1 in 37.0	1 in 18.5
EAST BOTTOMS, Missouri R.M. 357.6					
Future **WITHOUT** Project	746.30	1 in 500	1 in 41.7	1 in 16.9	1 in 8.7
Future **WITH** Project	746.30	1 in 3000	1 in 333.3	1 in 125.0	1 in 58.8
BIRMINGHAM, Missouri R.M. 355.9					
Future **WITHOUT** Project	743.00	1 in 500	1 in 66.7	1 in 27.0	1 in 13.9
Future **WITH** Project	743.00	No chg	No chg	No chg	No chg

Note: Any discrepancies due to rounding

Residual Risk.
In an environment where competition for public funds is keen, most communities cannot be made 100% safe from the threat of flooding. It is important that floodplain occupants are aware of the nature of the flood threats and are able to make informed decisions about acceptable levels of risk. Often however, the concepts of risk and probabilistic characterizations are difficult to understand.

The tables presented in this paper show that the recommended plan for the units addressed by this interim feasibility report provides a significant increase in reliability against flooding. Flooding will be less frequent; however, the analyses show there is still residual risk of flooding. For the Corps, determining an acceptable level of risk is in most cases a function of the NED process. The goal is to manage the risk of flooding within limited budget and funding constraints, and yet implement a cost effective and efficient flood damage reduction plan that reasonably maximizes net economic benefits (flood damage reduction benefits) consistent with protecting the Nation’s environment (NED plan).

From the Federal perspective, selection of the NED plan as the recommended alternative is a determination of an acceptable level of residual risk based on trade-offs between potential benefits and the associated level of residual risk versus the cost of a larger and more risk-adverse flood damage reduction project. Increases in project reliability above what is provided by the NED plan can sometimes be achieved with much larger projects. However, in most instances, costs for larger projects increase dramatically faster than project benefits. The NED plan maximizes net benefits as measured by the difference between annual benefits and annual costs..

From the local perspective, a community or sponsor may desire less residual risk of flooding than that provided by the NED plan. Many persons in a community might express the desire for zero residual risk and no chance of damage from a recurrence of flooding, even though this is an economically unattainable goal. The level of risk a community (or sponsor) is willing to bear can be indicated by their willingness to pay for each additional increment of flood risk reduction. In accordance with Federal law, if a larger (more costly) “Locally Preferred Plan” than the NED plan is selected (a plan that may have higher benefits, higher costs and fewer net benefits than the NED plan), the project sponsor is required to “buy-up” or pay the difference in cost between the NED plan and the Locally Preferred Plan.

Other Considerations Related to Risk and Reliability

It is important to bear in mind the variability and uncertainty associated with the inputs to a risk and uncertainty analysis.

- Care must be taken to consider the entire output of the analysis rather than placing undue reliance on any one statistic.
- Such simulations are sensitive to assumptions about correlations between parameters, the likelihood that a particular specification is correct, any omitted factors, and assumptions about the appropriate distribution for parameters, etc.
- Generally, the quality of the overall analysis is reflective of the quality (or accuracy) of its input components.

This interim feasibility study is, in many respects, a groundbreaking effort with regard to the scale and scope of effort. In the past, many Corps studies have been performed using risk and uncertainty principles for planning smaller levee systems limited to flood events at or about the 1% event. The target conveyance in the original authorizations places this system in the upper echelon of U.S. levee systems. This makes it difficult for direct comparisons to other levee systems of the results and reliabilities produced by this analysis. The possibility for better characterization and comparison for residual risk is expected as the number of larger levee systems analyzed using risk and uncertainty principles increases over time.

In general, water resource development and planning continues to be a field where judgment and context plays a vital role. There can never be one exact solution to all conceivable issues. The feasibility process undertaken in this study allows for a reasoned and systematic approach to formulating plans. However, natural environments and especially the dynamic characteristics inherent in river systems, remain subject to re-interpretation and refinements as the knowledge base and experience with those systems grow over time.

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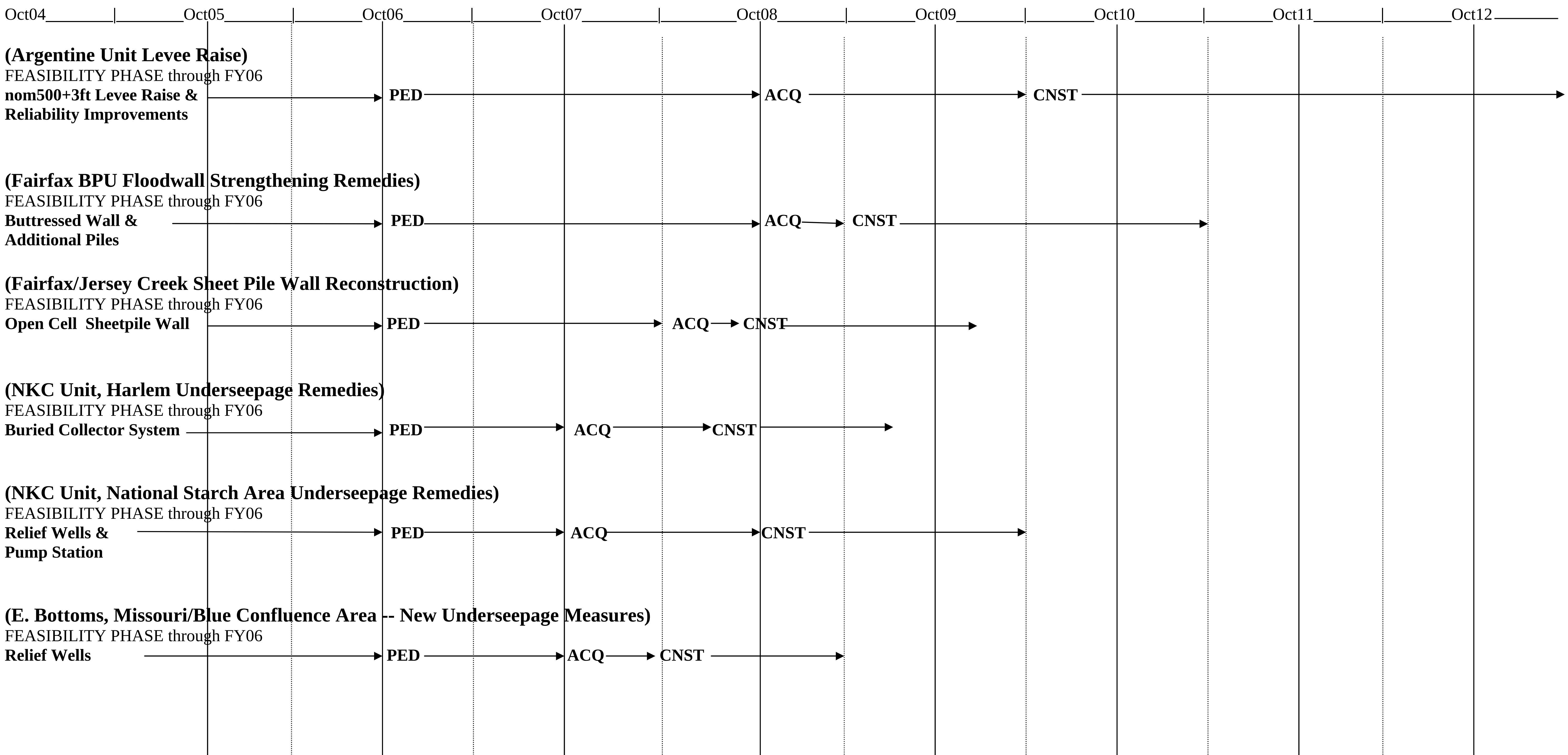
EXHIBIT #18: PROJECT SCHEDULE, KANSAS CITYS LEVEES INTERIM FEASIBILITY REPORT RECOMMENDED PLAN Aug 2006



NOTES:
PED – Engineering and Design ACQ – Real Estate Acquisition CNST – Construction

"This schedule reflects the information currently available and the current departmental policies governing execution of projects. It does not reflect program and budgeting priorities inherent in either the formulation of a national civil works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the schedule recommended may be modified before it is transmitted to higher authority for authorization and/or implementation funding."